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Determination of the serum zinc level in urban and rural dogs of Ahvaz district, Southwestern Iran

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Abstract

Zinc is one of the most important nutrients in determining the appearance of the coat in dogs. Zinc deficiency occurs, most commonly as zinc responsive dermatosis, but zinc toxicity rarely occurs. The present study was conducted to detect the level of serum zinc concentration in urban and rural dogs of Ahvaz district, by atomic absorption spectrophotometry. A total of 250 serum samples of urban and rural dogs (clinically healthy) with different ages were randomly obtained. The classification was made by age, sex, breed and location. The dogs were divided into three groups based on age (≤1 year, 1-3 years and ≥3 years). The mean and standard deviation of zinc concentration was 1.21±0.04 mg/l in the studied dog's population. The frequency distribution of zinc showed that serum concentrations were 1.36±0.06 and 1.05±0.05 mg/l in urban and rural dogs respectively. The mean and standard deviation of zinc was in the normal range in all samples (1.21±0.04; 95% CI: 0.87-1.42). Serum zinc concentration was significantly higher in urban than rural dogs. Zinc concentration didn't show a significant difference for different ages (1.16±0.09 less than one year, 1.15±0.06 between 1-3 years and 1.27±0.07 above 3 years), gender (1.41±0.10 in males and 1.33±0.08 for females in urban dogs and 1.06±0.07 in males and 1.03±0.08 for females in rural dogs), and breed (the most level in Boxer breed= 1.42±0.60 and the least level in Bulldog breed= 0.87±0.18) (p>0.05). The present survey showed that the serum zinc concentration was significantly higher in the urban than rural dogs which are probably due to the better diet.

Keywords: Zinc, Dog, Serum, Ahvaz

Introduction

Zinc is an important cofactor and modulator of many critical biological functions (Scott et al. 2001). Zinc contributes to the structure and function of important metalloenzymes, including carbonic anhydrase, alkaline phosphatase, RNA and DNA polymerase, and alcohol dehydrogenase (Favier et al. 1994). Zinc is required in over 200 enzymes and so deficiency is likely to affect several different systems. There is considerable evidence for the role of trace elements particular zinc in the maintenance of a healthy coat and skin in the literature. Dietary factors have a major role in this field and are significant in the etiology and therapy of certain skin diseases (Evans and Halliwell 2001). Nutritional deficiencies are now uncommon as a result of the widespread feeding of complete and

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balanced pet foods. Zinc-responsive dermatosis is reported in different breeds of dogs. It is resulting from either an absolute or relative deficiency in zinc (Colombini 1999, Campbell and Crow 2010). Zinc deficiency has been associated with poor quality diets in which dietary interactions have reduced the availability of zinc. Some young puppies and pregnant dogs, as well as performance dogs, or animals with skin problems, may require more supplemental zinc than is being fed in the diet (Kearns et al. 2000).

In adults, signs of zinc deficiency are confined mainly to the skin, but these may be accompanied by growth failure and other abnormalities in young animals. Appetite may be decreased in affected animals as a result of a diminished sense of taste and smell; prolonged deficiency can result in weight loss, impaired wound healing, conjunctivitis and keratitis. Generalized lymphadenopathy is also a common feature, particularly in young animals. Impaired immune function with zinc deficiency can lead to the development of respiratory, gastrointestinal, or other infections. Absolute dietary deficiencies of zinc are considered rare in dogs but have not been reported in cats (Romanucci et al. 2011, Beigh et al. 2017). In the northern hemisphere, many outdoor dogs shed to varying degrees in spring and fall, indoor pets may shed all year long. Hair is composed of 95% protein, which is rich in the sulfur-containing amino acids, methionine and cystine. Normal growth of hair and keratinization of the skin creates a high demand for protein and may account for between 25 and 30% of the animal's daily protein requirement (Scott et al. 2001, Tilley and Smith 2005). Healthy dogs should only shed twice a year due to seasonal and temperature changes. The present study was conducted to detect the level of serum zinc concentration in urban and rural dogs of Ahvaz district. To our knowledge, the present survey is the first research in dogs in Iran.

Materials and methods

A total of two hundred and fifty serum samples of urban and rural dogs were randomly obtained with different ages. All the studied dogs were clinically healthy. Decreased appetite, weight loss, shedding of hair or any other diseases related to zinc deficiency were not seen in the studied dogs. The urban dogs were selected between referred cases to the Veterinary Hospital of the Shahid Chamran University of Ahvaz, southwestern Iran. Rural dogs were selected between the rural dog's populations of Ahvaz suburbs. The classification was made by age, sex, breed and location. The studied dogs were divided into three groups based on age (≤1 year, 1-3 years and ≥3 years) and the rural dogs were categorized into four regions based on the area (north, east, west and south). Blood samples were taken from the cephalic or saphenous veins and centrifuged at 2400 g for 10 minutes. The serums were collected in plastic tubes and stored at -20 C until analysis. Serum zinc concentration was measured based on the biochemical analysis and by atomic absorption spectrophotometry (Shimadzu, UV-AA-6200, Japan). The analysis was carried out according to the manufacturer's instructions. Serum zinc was chelated by 5-Br-PAPS in the reagent. Normal serum zinc concentrations generally range between 0.7- 2 mg/l in dogs and 0.5-1.1 mg/l in cats (Tilley and Smith 2005).

Dogs were grouped by age, gender, breed, and location. Obtained data were analyzed using Mann Whitney, Kruskal Wallis and Spearman rank correlation, by SPSS 16.0 statistical software. Differences were considered significant when $p< 0.05$.

Results

The mean and standard deviation of zinc concentration was 1.21±0.04 mg/l in the studied dog's population. Zinc serum levels were 1.36±0.06 and 1.05±0.05 mg/l in urban and rural dogs respectively. The mean and standard deviation of zinc was in

the normal range in all samples (1.21±0.04; 95% CI: 0.87-1.42). Serum zinc concentration was significantly higher in urban dogs in compare with rural ones ($p<0.001$). Zinc concentration was not significantly different between age groups (1.16±0.09 less than one year, 1.15±0.06 between 1-3 years and 1.27±0.07 above 3 years), gender (1.41±0.10 in males and 1.33±0.08 for females in urban and 1.06±0.07 in males and 1.03±0.08 for females in rural dogs), and breeds (the most level in Boxer breed= 1.42±0.60 and the least level in Bulldog breed= 0.87±0.18) ($p>0.05$). In this survey, the mean age of studied dogs was 33.78±27.73 months. The breed distribution of urban dogs was Mixed breed (24%), German shepherd (21.6%), Terriers (18.4%), Spitz (11.2%), Doberman pinscher (9.6%), Pekingese (4%), Great Dane (4%), Boxer (3.2%), Bulldog (2.4%) and Rottweiler respectively (1.6%). The breed distribution of rural dogs was Mixed breeds (84%), German shepherd (8.8%), Doberman pinscher (4%), Terrier (2.4%) and Pekingese (0.8%) respectively. The mean level of zinc concentration was significantly higher ($p<0.001$) in dogs which were fed with diets contains more meat products. Urban dogs were mainly fed with homemade diets, but the quality of rural dog's diet was very poor. Changes of the serum zinc concentrations are shown in Tables 1-4 based on age, gender and area.

Table 1. Villages of sampling location and number of samples taken from each location

Villages of Ahvaz different districts	Number of samples
North	33
South	30
West	32
East	30
Total	125

Table 2. Mean±standard deviation of zinc concentration (mg/l) based on gender and location in urban and rural dogs of Ahvaz district, Southwestern Iran

Urban dogs (n=125)		Rural dogs (n=125)	
Male	**Female**	**Male**	**Female**
58 (46.4%)	67 (53.6%)	71 (56.8%)	54 (43.2%)
1.41±0.10	1.33±0.08	1.06±0.07	1.03±0.08

Table 3. Mean±standard deviation of zinc concentration (mg/l) based on age and location in urban and rural dogs of Ahvaz district, Southwestern Iran

Urban dogs (n=125)			Rural dogs (n=125)		
<1 year	**1-3 year**	**>3 year**	**<1 year**	**1-3 year**	**>3 year**
53 (42.4%)	44 (35.2%)	28 (22.4%)	49 (39.2%)	41 (32.8%)	35 (28%)
1.45±0.11	1.30±0.09	1.31±0.14	1.09±0.08	1.02±0.08	1.02±0.11

Table 4. Mean±standard deviation of zinc concentration (mg/l) based on age in the studied dogs' population of Ahvaz district, Southwestern Iran

Total population of dogs (n=250)		
≤1 year	**1-3 year**	**≥3 year**
1.16±0.09	1.15±0.06	1.27±0.07

Discussion

The present study showed that the serum zinc concentration was in the normal range in all samples (0.87-1.42 mg/l) but it was calculated significantly higher in urban dogs in compare with rural ones (1.36±0.06 against 1.05±0.05 mg/l) which are probably due to the better nutrition. To our knowledge, our survey is the first research in companion dogs in Iran and the obtained results showed that zinc deficiency is not a great concern in our region.

Many factors including environment, hormones, and diet can affect the serum zinc status in pet animals (Scott et al. 2001). Zinc is one of the most important nutrients in determining the appearance of the coat. Two general types of abnormality of trace element status can be identified: a specific deficiency arising from dietary inadequacies and imbalance resulting from the disease. In both cases, trace element status can be adequately assessed by serum elemental analysis (Peters et al. 2003). The added zinc helps to maintain skin moisture, preventing dryness and improving the barrier function of the skin (Hensel 2010). Trace element status must be adequately assessed by serum elemental analysis in suspected cases. It is not clear whether depression in serum zinc concentrations in dogs with excessive shedding originated from a low concentration of the mineral in the diet, impaired absorption or genetic factors. In the present survey, the mean level of serum zinc concentration was significantly higher in dogs that were fed with meat-based containing diet.

Oral zinc supplementation, together with dietary correction, where appropriate, brings rapid resolution of signs in most cases (Scott et al. 2001, Tilley and Smith 2005). Relative or absolute deficiency of zinc has been documented in Bull terriers with lethal acrodermatitis, zinc responsive dermatitis in Siberian huskies and Alaskan malamutes, and rapidly growing puppies fed with zinc-deficient diets (Jezyk et al. 1986, Uchida et al. 1997, Mc Ewan et al. 2000). The best sources of zinc are meats, fish and whole grain. High levels of dietary phytate, found in cereal-based diets, chelates zinc. A poorly formulated dog food has been known to cause a mineral deficiency in dogs (Watson 1998).

In our study, most of the studied dogs were fed with homemade diets particularly in urban dogs and zinc concentration did not show a significant difference for different ages, gender and breed; but sensitive breeds to zinc deficiency such as Siberian husky were few in our survey. The first case of the zinc-related disease in the dog was reported in an Alaskan malamute with chondrodysplasia based to the malabsorption (Van den Broek and Thoday 1986). Cases of skin diseases associated with zinc deficiency have been reported in dogs especially in Labrador Retrievers (White et al. 2001).

The diagnosis of zinc-responsive dermatosis must be based on a thorough history, physical examination, skin scraping for differential diagnosis and histopathological examination of skin biopsies (Beigh et al. 2017). Mosallanejad and Avizeh (2012) reported the possible role of zinc in excessive shedding of hair in two Persian cats.

Maternal zinc deficiency is teratogenic in human. Studies concerning the alterations in levels of trace elements are complicated in excessive shedding of hair by the fact that the trace elements are multi-functional. Although it is difficult to prove that a specific deficiency causes specific skin disease, but it is reported that high dietary calcium content to a vegetable protein-based diet can dramatically increase the zinc requirement and this latter effect may be related to that reported for iron absorption. Dietary supplementation may be required to correct zinc deficiency, but care should be exercised to avoid the risk of toxicity. The best premium and holistic foods feature a combination of fats, carbohydrates, vitamins, minerals and

protein sources to keep the animal healthy (Scott et al. 2001, Tilley and Smith 2005).

Calcium supplementation in fast-growing breed can precipitate zinc-responsive dermatosis (type II) and thus there is a need of feeding these animals with high-quality food (Beigh et al. 2017).

In the present study, all the studied dogs were healthy and had no clinical signs of excessive shedding of hair in their history. Decreased appetite, weight loss, shedding of hair or any other diseases related to zinc deficiency were not seen in dogs. Although signs of zinc deficiency are confined mainly to the skin, decreased appetite is probably due to a diminished sense of taste and smell. Other skin disorders (such as erythema, alopecia, pyoderma, scale and crust) had not shown in the studied animals.

Bexfield et al. reported a diagnosis of hemolytic anemia secondary to acute zinc toxicity in a dog, which was strongly regenerative. Serum zinc concentrations were markedly elevated also. More commonly referred to as zinc toxicity, it occurs when animals ingest an exorbitant amount of zinc-containing materials. Though mostly reported in small breed dogs, zinc toxicity can affect dogs of all sizes (Bexfield et al. 2007, Bischoff et al. 2017). A presentation of zinc toxicity was announced secondary to prolonged ingestion of a zinc oxide cream in an ovariohysterectomized female Poodle. The serum zinc concentration was markedly elevated. The animal was treated supportively and made a full recovery. Zinc toxicity can have a good prognosis when diagnosed and treated promptly (Siow 2018).

Treatment with oral zinc sulphate will produce a rapid resolution of physical signs and restoration of serum zinc concentrations to the reference range (Beigh et al. 2017). The monitoring of trace element concentrations especially with treatment opportunity will be helpful to clarify the reason for alterations in trace elements in dogs. Our results will be the basis of further studies that will permit to increase our knowledge about the importance of zinc in small animals. Furthermore, another survey in the symptomatic dogs must be noticed. Further studies in various geographical areas are recommended. In conclusion, the present survey showed that the serum zinc concentration was significantly higher in the urban than rural dogs which are probably due to the better diet.

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Conflict of interest

The authors declare that they have no conflict of interest.

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