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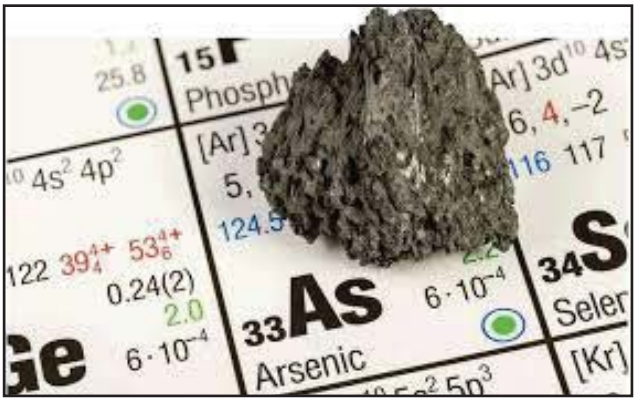
Arsenic in petfood

Online commentaries on detection of arsenic in pet and baby foods (cf. 1-6) probably stirred up concern among some pet parents, especially when they know arsenic as poison used in older detective stories. Arsenic is not intentionally added to petfood, but the pervasive earth element is intrinsic to many ingredients. Possibly, arsenic is an essential nutrient for dogs and cats, albeit in tiny amounts. Arsenic, often referred to as heavy metal, is toxic only in high quantities, but with its chemical form as a co-definer.

European legislation has set upper limits for arsenic in complete food for dogs and cats (7). The maximum is 2.3 mg total arsenic per kg canned or kibbled food when completely dried. However, the maximum is 11.4 mg when the food contains (derivatives of) fish and/or seaweed. That higher maximum unifies practical and health considerations (8): the two aquatic products are relatively rich in arsenic, but in a form of low toxicity.

Chemical analysis of total arsenic in complete petfoods indicates typical compliance with European legislation. Absorbed arsenic compounds are converted by the dog's liver and/or kidneys and then excreted with urine. Research data show that long-term intake of up to 20 mg total arsenic per kg dry weight of food is not toxic for dogs. Thus, commercial dog foods are generally safe with regard to their levels of total arsenic. In cats, the maximum tolerated dose of dietary arsenic is unknown.

Accidental ingestion of products containing a toxic amount of arsenic can cause acute poisoning in dogs and cats. Such products used to be herbicides, insecticides and wood preservatives (9, 10), but today ant and roach baits are major culprits (11, 12). Symptoms are vomiting, salivation, abdominal pain, staggering gait and diarrhea. Affected pets should be taken to a veterinary facility immediately.



Dietary arsenic

Concentrations of total arsenic (As) in dry and wet petfoods are mostly lower than 2.3 mg/kg dietary dry matter (ddm) (13-19). Higher values are only found in foods containing fish derivatives (8, 13, 18, 20). Percent inclusion of fish and As in food were positively related (20). Total As in fish-based dog and cat foods normally is well below 11.4 mg/kg ddm (8, 13, 18, 20), but a higher level is sometimes found (8, 20). Thus, the European allowable limits are usually not exceeded.

As is ubiquitous and thus may be found at detectable amounts in petfood ingredients. Moreover, marine fish, seaweed and rice concentrate As from the environment. Fish meal and oil, hijiki seaweed and rice may have total As contents of up to 20 and 14 (21), 34 (22) and 2 (23) mg/kg dry weight. In finfish, As mainly occurs as arsenobetaine, whereas fatty fish and seaweed contain arsenolipids (21, 24) and arsenosugars (22). Rice contains inorganic As, but speciation is variable (25).

Metabolism

Three hours after a single oral dose of 74As as arsenic acid (H3AsO4), about 90% of the radioactivity was present in dog's blood (26), pointing to high absorption. In contrast, dogs poorly absorbed As from arsenate bound to bog ore (27). Dogs excrete negligible amounts of As into bile (28). However, the canine kidney reduces arsenate to arsenite for excretion (29, 30) and also excretes As as dimethylarsinic acid (DMA) (26, 30-32).

As ingested in the form of arsenate or arsenic sulfide is converted into DMA by dogs (26, 30-32). Biomethylation of inorganic As, which takes place in the dog's liver (33), appears unreported for cats. Interestingly, arsenic oxide was highly toxic for a feline kidney cell line, but DMA was not (34).

Toxicity

The results of five toxicity studies (35-39), indicate that long-term intake of 20 mg total As/kg ddm is not toxic in dogs. Inorganic As sources were tested, except for one study (36). The highest, analysed value reported for commercial petfood was 18.9 mg/kg ddm, which concerned a fish-based, wet food (20). Two-year toxicity studies in dogs (36, 37, 39) did not mention cancer development. Toxicity feeding studies in cats are lacking. Intravenous administration of arsenic trioxide, as uncorrected equivalent of 26 mg As/kg ddm for 6 days, was toxic in cats (40).

Toxicity of trivalent arsenicals, such as arsenite, relates to their reaction with thiol-containing molecules. In dogs, administration of lipoic acid, a dithiol and co-factor of various enzymes, prevented arsenite toxicity (41). Harm by pentavalent arsenate may result from replacing phosphate in biochemical reactions. In rats, dietary inorganic phosphate partly counteracted arsenate toxicity (42).

Oral toxicity of arsenicals in descending order, on the basis of acute LD50 values in rodents, is as follows: arsenite, arsenate, DMA, arsenobetaine (43). Arsenobetaine is non-toxic due to readily excretion in the urine intact. Arsenolipids and arsenosugars may be metabolized into di-methylated arsenicals that could exert toxic effects (44, 45). Canine and feline metabolism and toxicity of those dietary, organic arsenic forms are unknown.

Arsenic exposure

Dogs that ingested sodium arsenite for four months, at three intake levels including zero, showed dose-dependent As concentrations in urine, liver and hair (46). Urine may be an indicator of recent dietary As exposure, whereas hair reflects the longer term. Hair As was very high in dogs from an area with As-rich groundwater (47, 48). Liver As did not differ between dogs from rural and urban areas (49).

List of references is available on request from the author (beynen@freeler.nl)

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