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Intake of minerals, trace elements and vitamins in bone and raw food rations in adult dogs

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Abstract

The aim of the present study was to evaluate the vitamin and mineral content of bone and raw food rations fed to adult dogs in Germany. Pet owners completed a standardised feeding questionnaire. The composition of 95 rations was calculated from mean data for foodstuffs using nutrition balancing software. Typical ration ingredients were meats, fish, offal, dairy products, eggs, oil, nuts, cod liver oil and natural and commercial supplements. The supply of nutrients was compared with the recommended allowance (RA). Of the rations that were used, 10 % supplied < 25 % of the RA of Ca. In these rations, Ca:P was below 0·6:1, and vitamin D was below RA. About half of the rations supplied less iodine than the minimum requirement. Many of the rations had low Zn and Cu supply, and 25 % of the rations supplied only 70 % of RA for vitamin A or less. A total of 60 % of the rations had one or more of the above-mentioned imbalance. The remaining 40 % of rations either had minor problems like Ca excess from bones or they were balanced.

Key words: Raw feeding: Supply of nutrients: Nutritional imbalance

Interest in bone and raw food rations (BARF) has increased recently in the nutrition consultation practice in Germany. Home-made food tends to be nutritionally imbalanced[1–3]. Therefore, we wanted to identify nutritional imbalances typical for BARF rations to provide veterinarians with some indications as to which nutritional disorders might be associated with these diets.

Methods

A nutrient evaluation of BARF rations was offered at a reduced price at the University of Munich (Ludwig-Maximilians-University) and a private nutrition consultation practice 'Futtermedicus'. This was advertised on each institution's webpage. Contact was made by phone, fax or e-mail. The owners were asked to complete a standardised feeding questionnaire used in these two practices for ration calculation. This questionnaire requested information concerning the dogs such as breed, age, sex, activity, actual body weight and body weight at the age of about 1·5 years (considered to be more or less normal weight). The questionnaire also asked about the type and amount of food (meat, fish, bones, vegetables, fruits and supplements), specifically asking about the use of supplements using two different phrasings. The nutritional composition of the rations was calculated using a computer program (Diet Check Munich©). This computer program includes data on meat and meat by-products such as heart, liver, rumen, lung and throat based on analyses and digestion trials with dogs, as reported by Meyer & Heckötter[4]. Metabolisable energy was calculated from data on digestible energy minus 5·2 kJ/g digestible crude protein (National Research Council, 2006). Other values were taken from Souci *et al.*[5]. For these metabolisable energy was calculated by Atwater factors (16·7, 37·7 and 16·7 kJ/g (4, 9 and 4 kcal/g) protein, fat and carbohydrate, respectively) as recommended for home-made food[6]. Some bone supplements were bought at a butcher's shop, and analysed as described previously[7] (Table 1). If the energy intake of the dog as calculated from the reported food intake deviated considerably from the requirements for the respective dog according to age, breed, activity and housing, we questioned the owner specifically for possible sources of error. Intake of Ca, P, Mg, K, Na, Fe, I, Zn, Mn, Cu, vitamin A and vitamin D was compared with the recommended allowance (RA), based on National Research Council[6] on an actual metabolic body weight basis. The owners were informed about the result, and in the case of nutrient deficiencies or excess most rations were corrected (data not shown), addressing specifically such sources of error as the amount of bone given to the dog and the amount eaten by the dog.

Abbreviations: BARF, bone and raw food rations; RA, recommended allowance.

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Table 1. Nutrient composition of bone products

Feed stuff	*n*	DM (% wet weight)	Crude protein (% wet weight)	Crude fat (% wet weight)	Crude ash (% wet weight)	Ca (g/kg wet weight)	P (g/kg wet weight)	Na (g/kg wet weight)	K (g/kg wet weight)	Mg (g/kg wet weight)	Fe (mg/kg wet weight)	Zn (mg/kg wet weight)	Cu (mg/kg wet weight)	Mn (mg/kg wet weight)
Chicken thigh	2	33/31	19/17	12/10	3/3	9/6	6/4	1/1	3/3	0,3/0,3	20/19	21/21	1/1	1/1
Chicken wings	3	35/35/36	18/18/19	13/11/12	4/4/4	11/11/12	8/7/8	1/1/1	3/3/3	1/1/1	23/24/22	23/22/24	1/1/1	1/1/1
Chicken neck	1	30	17	7	5	17	11	4	NA	NA	NA	NA	NA	NA
Dried chicken neck	3	97	53/56/56	25/26/25	17/18/16	53/56/56	32/33/33	3/3/3	5/5/5	2/2/2	89/90/94	111/118/122	3/3/3	3/4/4
Ox tail 'fleshy'	1	43	23	14	5	13	7	2	4	0·5	18	57	1	1
Ox tail 'bony'	1	54	19	24	10	40	20	2	2	1	17	37	2	1
Swine tail 'bony'	1	55	19	21	14	60	32	3	2	1	19	54	2	1

NA, not analysed.

Results

Dogs were 23 % female, 30 % male, 31 % neutered female, 16 % neutered male, with a mean age 4·4 years and the mean body weight was 26·4 (range 4–72) kg. Only 11·5 % of the dogs were more than 10 % above their weight at 1·5 years. Many owners reported that their dogs were undertaking a considerable amount of physical activity, such as hunting or agility. Typical ingredients of BARF rations were meat (e.g. horse, lamb, chicken, beef, duck, veal and venison) and offal (e.g. heart, liver and rumen), bones, fish, dairy products, vegetables and fruits and plant oils. Supplements included egg yolk, cod liver oil, seaweed, nuts, linseed, sesame, coconut flakes, eggshell, bone meal, herbs and/or some commercial mineral mixtures. Of the pet owners, 26 % also fed small amounts of cooked carbohydrate (rice, potatoes, pasta or cereal flakes) and/or commercial dry kibbles were used as treats ($<$20 % of energy from carbohydrates). Reported daily energy intake averaged 452 (SD 113) kJ (108 (SD 27) kcal) metabolisable energy/kg actual body weight$^{0·75}$ (range from 251·0 kJ (60 kcal) in an 14-year-old neutered Dachshund to 723·8 kJ (173 kcal) in a 1·5-year-old bearded Collie). Table 2 shows the distribution of nutrient intake. Of the rations that were used 10 % supplied $<$25 % of RA of Ca. In these rations, Ca:P was below 0·6:1, and all these rations supplied considerably less vitamin D than RA – assuming meat contains little or no vitamin D. About half of the rations contained less than the National Research Council (2006) minimum iodine requirement. More than half of the diets supplied less than the RA for Cu and Zn. A total of 25 % of rations supplied only 70 % of RA for vitamin A or less. Of the rations, 60 % had one or more of the above-mentioned imbalances or a seriously unbalanced Ca:P ratio, or in one case of iodine excess. The remaining 40 % of the rations either had minor problems like Ca excess from bones or they were balanced. The balanced rations contained a combination of most of the following ingredients: bone, eggshell, seaweed, nuts, wheat bran, wheat germs, sesame seeds, linseed, liver, cod liver oil, coconut flakes and/or kibbles and mineral supplements.

Discussion

In the present study, values from the tables on food composition were used for ration calculation. The mineral content can be overestimated or underestimated, especially if the fat content varies. The same is true for the energy content, which was in the same range as in dogs with comparable activity eating other rations, which include major percentages of prepared food. This suggests that there was no systematic error. For some nutrients such as Se, it was not possible to use data from the tables. Such nutrients were not evaluated. For iodine, Zn and vitamin A and vitamin D, it is unlikely that feedstuffs that do not usually contain major amounts of these nutrients are underestimated. Meat is unlikely to contain large amounts of vitamin A independent of the feeding of the animal. Vitamin A content in the liver may vary, and thus it is possible that the actual intake may be somewhat different from the calculated data. We used a mean of 40 000 IU

Table 2. Distribution of nutrient intake as % of recommended allowance (RA) in bone and raw food rations
(Mean values, standard deviations, medians, ranges and percentiles, *n* 95)

	Mean	SD	Median	Range	Percentiles 10 %	25 %	75 %	90 %	Remarks
Ca	184	161	135	7–810	25	102	226	348	10 % of dogs ate <25 % of RA with Ca:P <0·6:1 in the diet, these low Ca rations mostly did not include bones or a supplement containing substantial amounts of Ca. 10 % of dogs ate more than 300 % of RA, mostly from bones
P	177	114	148	42–741	72	109	211	306	10 % of dogs ate 72 % of requirements or less; four of these had a Ca:P ratio ≥2:1
Mg	127	64	114	32–440	68	90	148	184	No rations below minimum requirement
K	143	89	132	51–420	84	107	162	198	
Na	228	117	200	75–738	114	150	278	358	No rations below minimum requirements or above safe upper limit
Fe	311	352	215	39–2335	132	170	322	452	5 % of dogs (three) ate less than RA, milk product based or white meat rations, below average energy intake, all three dogs had also Cu intake below RA
I	169	830	51	1–8070	4	12	110	163	Half of the rations supplied only about half of RA or less which is below the minimum requirement. These low iodine rations did not contain fish, seaweed or an iodine supplement. One ration contained eighty times the RA for iodine supplied by a seaweed product
Zn	97	60	76	27–400	37	58	129	183	Low Zn rations usually consisted of meat with only small amounts of bone and without either offal, Zn containing supplements or nuts bones
Mn	132	178	91	6–1421	22	36	156	279	
Cu	113	76	100	13–439	36	54	155	208	Low Cu rations were of the same ration type as low Zn rations and usually also deficient in Zn and I
Vitamin A	373	549	141	0–3965	18	70	463	1011	25 % of dogs ate only 70 % of RA or less, such rations did not contain liver and vegetables
Vitamin D	63	109	44	0–1005	0	7	102	116	In twelve cases vitamin D <50 % RA was combined with Ca intake <RA. Rations containing little vitamin D usually did not include either liver and cod liver oil

(12 000 RE)/100 g of beef liver. In Germany, a range between 10 000 IU (3000 RE) and 120 000 IU (36 000 RE)/100 g liver has been reported for slaughtered cattle[8]. Therefore, it is possible that we underestimated or overestimated the supply of vitamin A in the rations with large amounts of liver. A similar situation exists for marine products for iodine supplementation. For Ca, an overestimate is unlikely in the case of feed containing very little Ca such as meat. Errors are rather unlikely for eggshells, seashell carbonates, bone meal and commercial supplements. Fresh bones with meat, however, could present a source of error when the meat content is not estimated correctly (Table 1). Therefore, it is important to get a good description of the amount of meat in bone supplements like oxtail or dried and fresh chicken neck by the owners.

Self-reporting of food intake data has various sources of error. The major nutritional imbalances found in the present study are, however, unlikely to be artefacts caused by insufficient self-reporting. Bones given to the dog and reported but not eaten could lead to an overestimate of Ca intake. Such sources of errors were addressed when owners were questioned, and again when owners were advised on how to correct the rations, which was done in most cases of major nutritional imbalances. Thus, it is quite likely that rations without Ca-containing supplements – even if reported with some inaccuracy – are indeed Ca deficient. The same is true for iodine, where the potential sources are fish and seaweed. Rations without these are likely to be iodine deficient.

Clinical symptoms potentially associated with deficiencies were not reported except for occasional skin problems. This raises the question whether RA are overestimated or whether some symptoms may have gone unnoticed (such as subclinical thyroid problems) or whether these symptoms would only occur after prolonged feeding of an unbalanced ration in adult dogs. This is probably the case for Ca-deficient rations. A recent case report on an adult dog fed a Ca-deficient elimination diet described a lag time of 2 years before symptoms of Ca deficiency developed[9]. In puppies, the development of symptoms can be expected after a much shorter time of feeding a diet containing insufficient or excess Ca[10,11]. Therefore, given the frequency of oversupply and undersupply with Ca in adult dogs, it is extremely important to check and balance BARF rations for puppies.

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