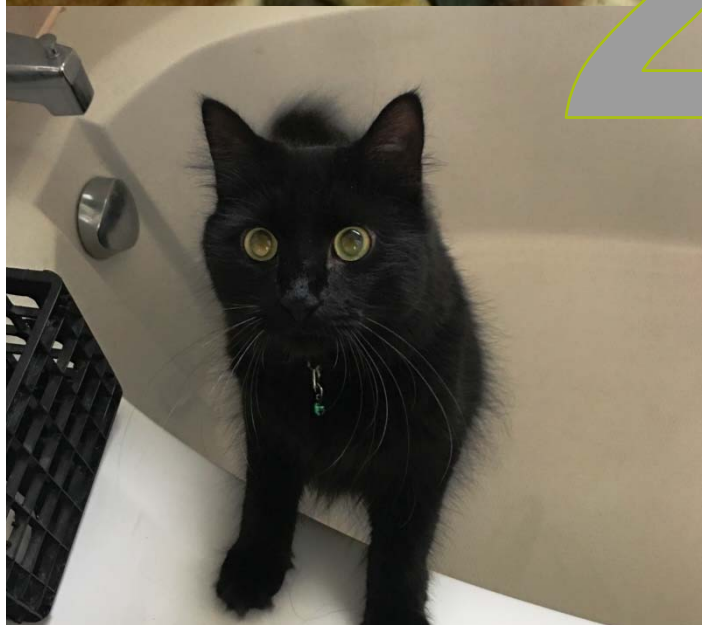
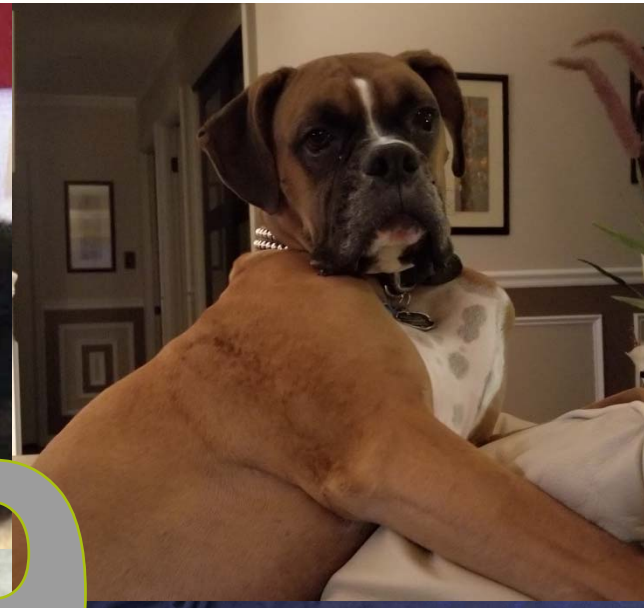


Heavy Metals in Pet Food: Changes in Heavy Metal Contamination in Pet Food Over the Past Decade

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Applications Scientist
SPEX CertiPrep

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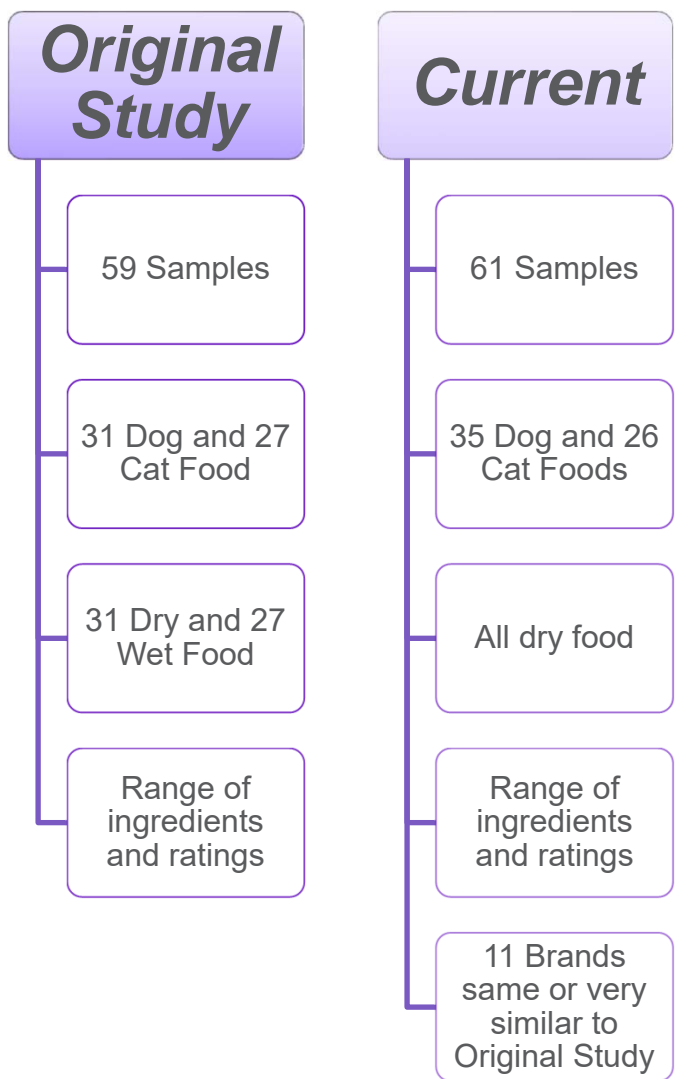
2019

Why study Pet Food?





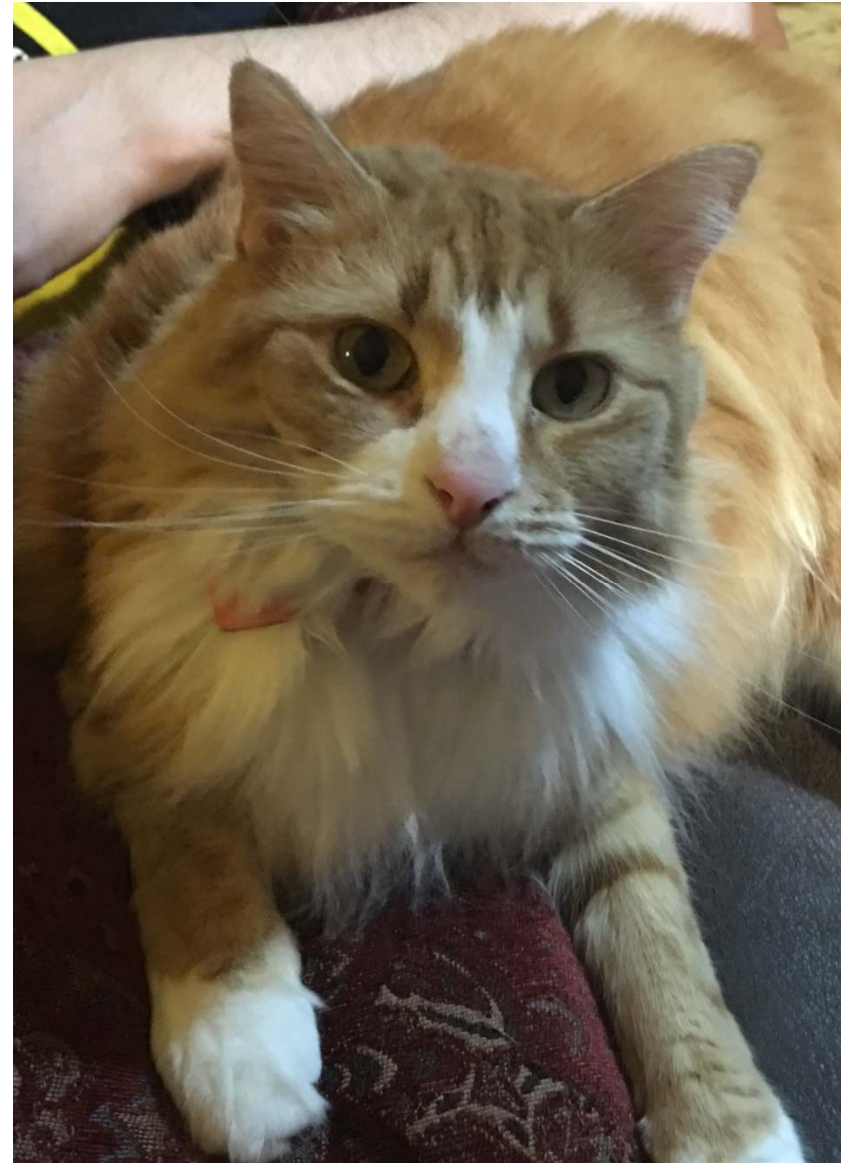
The Federal Food, Drug, and Cosmetic Act (FFDCA)



- 1938
- Required pet foods be:
 - *safe to eat*
 - *produced under sanitary conditions*
 - *free of harmful substances*
 - *truthfully labeled*
- Canned pet foods: free of viable microorganisms
- No pre-market approval requirement
- Labeling regulations:
 - identification of the product
 - net quantity statement
 - name & place of business
 - listing of all ingredients most to least by wt
 - ingredient standards & definitions
 - nutritional & ingredient info



- 2011
- Prevention
 - *Mandatory preventive controls for food facilities*
 - *Authority to prevent intentional contamination*
- Inspection and compliance
 - *Mandatory inspection frequency*
 - *Testing by accredited laboratories*
 - *Records access*
 - *Swabbing and inspection of environment by FDA*
- Imported Food Safety
- Response



- Before late 1800's early 1900's commercial pet food did not exist (canned food)
 - *Ken-L-Ration brand*
 - Post WWI
 - horsemeat
- After WWII
 - *consumer food companies capitalized on the ability to use human food by-products to produce pet food (\$200 million/ year)*
- After 1956, introduction of dry food
- 1980's saw specialized diets for ailments
- Newest trends – all natural, holistic



- Ingredients for Dogs and Cats should not be the same
 - Dogs - omnivores
 - *Diet: meat and carbohydrate sources*
 - *Require protein and carbohydrates*
 - Cats - obligate carnivores
 - *Diet: mostly meat sources less carbohydrates*
 - *Need high protein*
- Not digestible: fillers & carbs such as:
 - *Corn Gluten*
 - *Corn Meal*
 - *Wheat middlings*
 - *Ground white rice*
 - *Wheat germ*
- Where is the protein?

INGREDIENTS

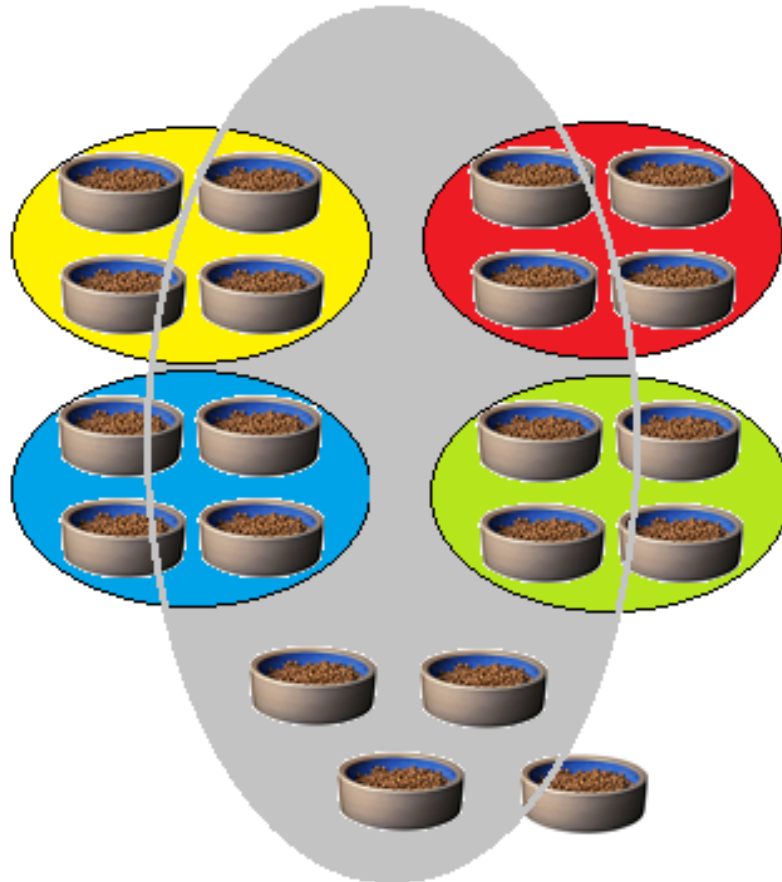
**GROUND YELLOW CORN
WHEAT MIDDLINGS
CORN GLUTEN FEED
RICE BRAN,
MEAT AND BONE MEAL
SOYBEAN MEAL
ANIMAL FAT PRESERVED WITH BHA**

Ingredients

**Whole Ground Corn
Poultry By-Product Meal
Corn Gluten Meal
Soybean Meal
Bone Meal
Animal Fat
Animal Digest
Menadione Sodium Bisulfite Complex**

- 2007: Big year in pet food
 - *Sales worldwide >\$45 billion*
 - *Massive recalls*
 - Many different companies
 - Many different brands
 - Dog & Cat Food
- Pet deaths caused by Melamine & Cyanuric Acid
- Source: counterfeit protein additives from Asian suppliers





>200 'brands' of
cat and dog foods

>80-90%
Four conglomerates

1 manufacturer
~50% brands
(variety of companies)

Adulterated supply of raw materials –
to increase protein counts = damaged all brands & killed pets

Toxic Agents

Liver

Iron
Phenols (in some cleaning products)
Acetaminophen
Arsenic
Tannic acid
Copper
Vitamin A
Blue-green algae
Cycad species
Amanita mushrooms
Hepatotoxic mycotoxins

Kidney

Lilies (in cats)
Nephrotoxic antibiotics
Diquat
NSAIDs
Oxalic acid
Cholecalciferol
Cadmium
Zinc
Rhubarb
Mercury
Cantharidin
Ethylene glycol
Phenolics

Elements of concern for pet exposure include:

- *Iron*
- *Arsenic*
- *Copper*
- *Cadmium*
- *Zinc*
- *Mercury*
- *Lead*

- Both studies obtained pet food through purchase and donations
 - SPEX & CEM
- Purchased foods from Supermarkets, Pet Stores, Chain stores (i.e. Walmart & Target etc.)
- Samples ground using liquid nitrogen SPEX SamplePrep Freezer Mill



SP

- Samples digested
 - CEM MARS 6 Microwave Unit
 - 0.5 gm of sample with 10 mL high purity Nitric Acid
- Microwave program: Pet Food (food program preloaded)
- Vessel Blanks run prior to sample digestion
- Diluted 1000X before ICP-MS

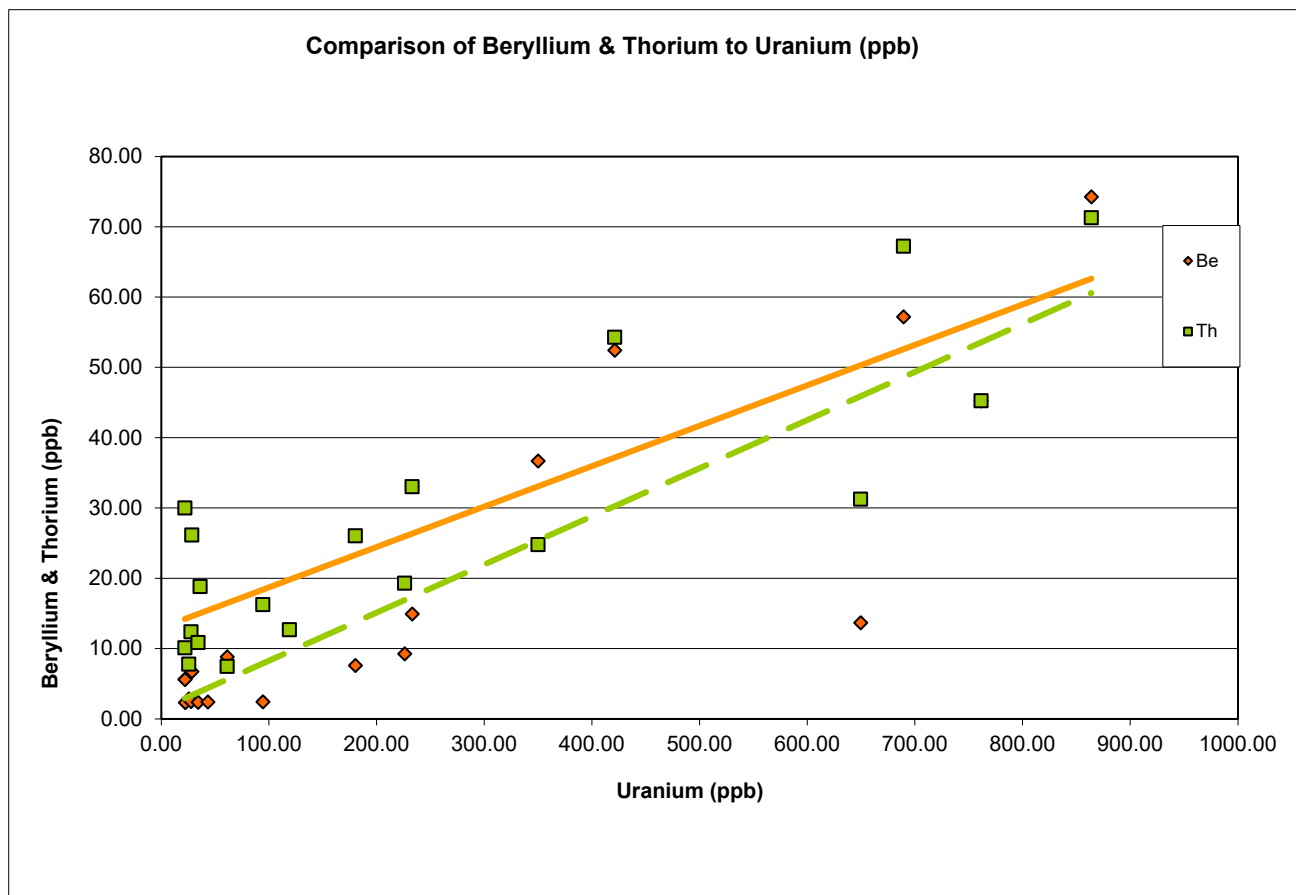


Element	Pet Food Min (ppb)	Pet Food Max (ppb)	Human Tuna (ppb)	Human Sardines (ppb)	Human Chicken (ppb)
Al	300	215000	1000	640	350
As	4	290	14	30	4
Be	2	74	6	4	3
Cd	2	130	36	14	2
Co	23	920	23	44	25
Cr	15	2500	25	41	20
Cs	1	30	14	16	3
Hg	ND	55	53	ND	ND
Ni	48	3200	180	380	950
Pb	3	5900	7	11	3
Sb	1	970	1	2	1
Se	64	1500	360	320	147
Sn	6	9400	98	28	6
Th	0	90	ND	0	0
Tl	1	10	1	3	2
U	0	860	0	6	0
V	5	7400	6	5	6

- Large variability
- High ppb / low ppm
 - 11 out of 16
 - 9 ppm Sn
 - 1 ppm U
- Toxic elements: human food samples < pet food
- Heavy metals present:
 - >1 ppm:
 - Cr, Pb
 - 0.5 ppm to 1 ppm:
 - Co & Sb

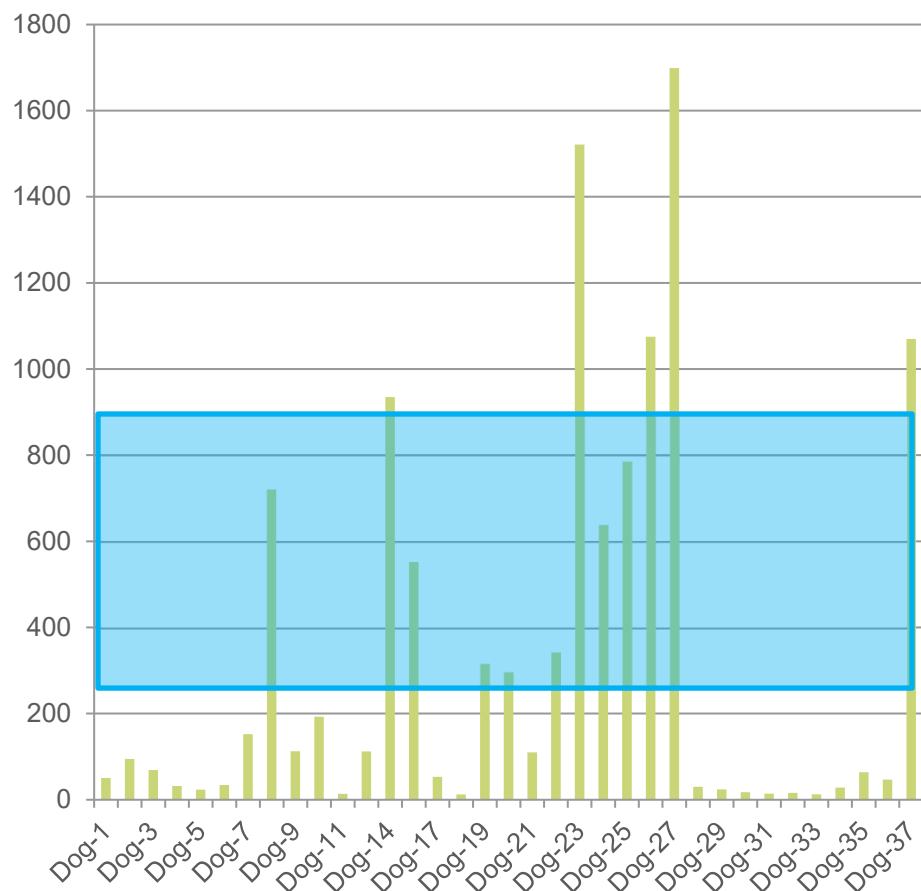
Element	2009 Pet Food Min (ppb)	2019 Pet Food Min (ppb)	2009 Pet Food Max (ppb)	2019 Pet Food Max (ppb)
Al	300	390	215000	86302
As	4	20	290	687
Be	2	ND	74	114
Cd	2	ND	130	152
Co	23	70	920	1343
Cr	15	397	2500	34191
Hg	ND	ND	55	146
Ni	48	354	3200	5879
Pb	3	16	5900	515
Sb	1	ND	970	318
Se	64	190	1500	1068
Sn	6	ND	9400	143
Th	ND	ND	90	147
Tl	1	ND	10	28
U	ND	ND	860	1699
V	5	43	7400	3339

- Large variability
- High ppb / low ppm
 - 6 ppm Ni
 - 1.7 ppm U (2x >2009)
- Heavy metals present:
 - >1 ppm:
 - Cr, Co
 - 0.5 ppm to 1 ppm:
 - As (3x > 2009)
 - Pb (10x < 2009)



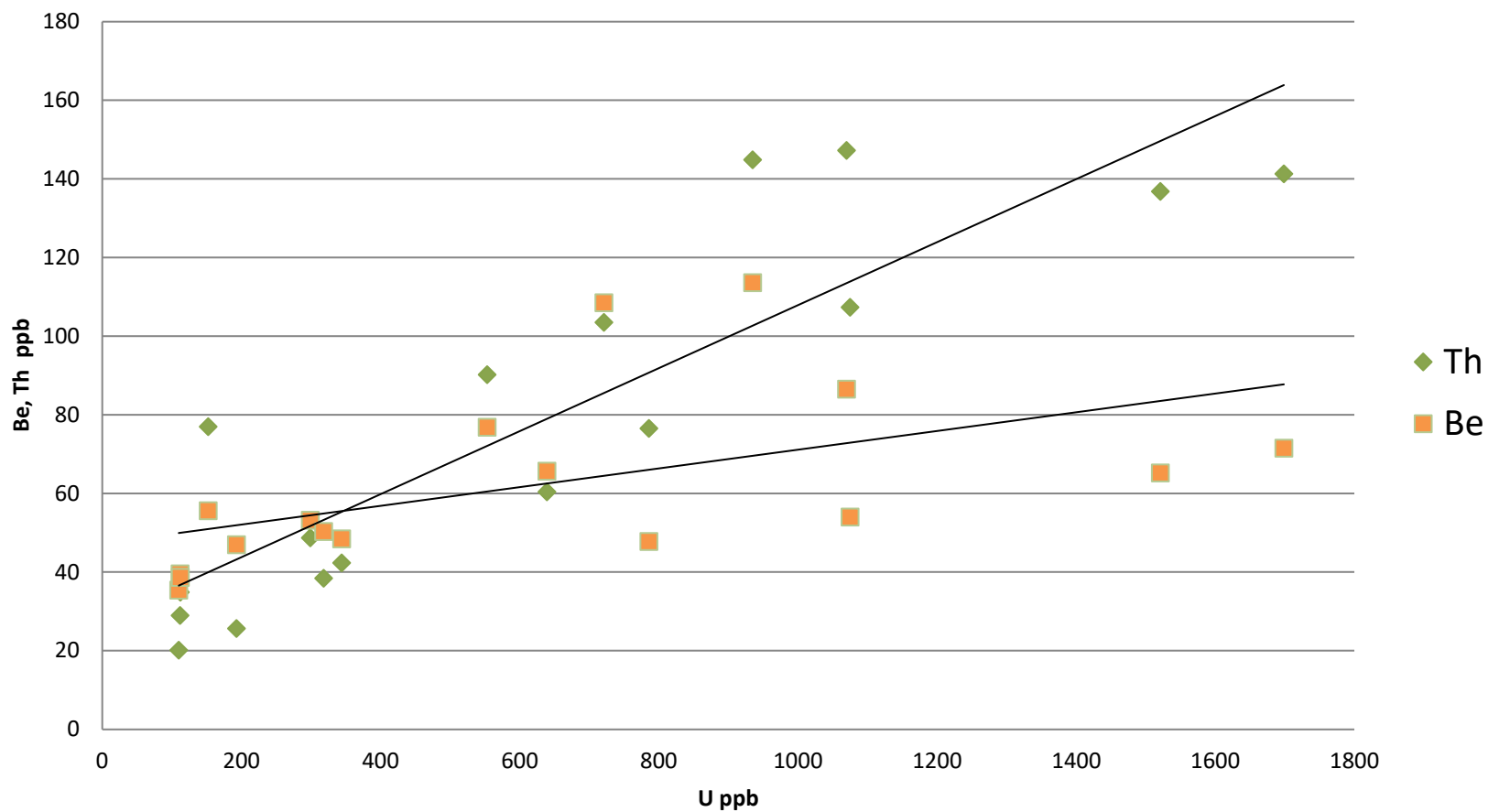
- Uranium > 250 ppb 6 samples
- All dry dog foods
- All contained a corn product
- 4 of 6 > 500 ppb & 1 = 1 ppm
- U levels, Increased Be, Th

U (ppb) 2019



- Uranium > 250 ppb 14 samples
- Most dry dog foods but two cat just over 250 ppb
- All contained a corn product
- 9 > 500 ppb
- 4 > 1 ppm
- U levels, Increased Be, Th

Comparison of Beryllium & Thorium to Uranium (ppb)





- Results calculated on wt of sample
- Converted to daily serving sizes
 - *Dry Dog Food = 5 cups = 500 g (2009)*
 - *2019: 3 cups = 300 g*
 - *Dry Cat Food = 1 cup = 100 g (2009)*
 - *2019: ½ cup = 50 g*
- Calculated to an average weight:
 - *10 lbs = Cats*
 - *50 lbs = Dogs*
- Limits for metals not reliably found for dogs & cats
- Human EPA & WHO guidelines were used (2009)

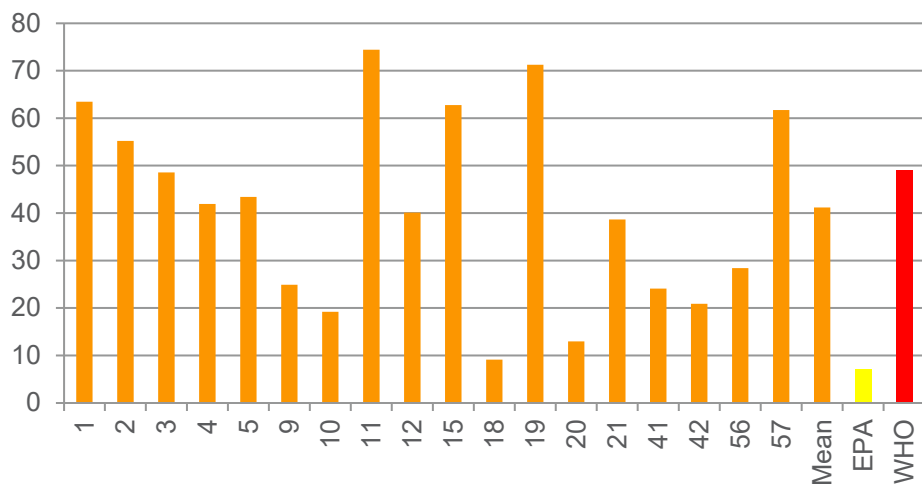
Element	EPA Human RfD ($\mu\text{g}/\text{kg}/\text{day}$)	EPA Human RfD (per 50 lbs body weight)	WHO Human TDI ($\mu\text{g}/\text{kg}/\text{day}$)	WHO Human TDI (per 50 lbs body weight)
As	0.3	7	2.14	49
Be	2	45	-	-
Cd	1	23	1	23
Hg	0.1	2.3	0.4 to 2 $\mu\text{g}/\text{kg}/\text{day}$ depending on type of Hg and literature source	9.08 (based on 0.4 $\mu\text{g}/\text{kg}/\text{day}$)
Ni	20	454	12	272
Pb	-	-	3.6	82
Sb	0.4	9	6	136
Tl	0.1	2.3	-	-
U	3	68	0.6	14

ID#	As	Cd	Hg	Ni	Pb	Sb	U
1	63	21	4.0	290	39	17	36
2	55	39	9.3	613	70	14	228
3	49	21	1.1	306	43	20	7
4	42	19	3.2	192	40	18	9
5	43	15	4.0	223	87	22	13
9	25	17	10.6	154	23	24	195
10	19	21	16.1	833	36	157	28
11	74	35	3.2	277	36	24	259
12	40	20	1.6	304	53	289	3
15	63	14	ND	433	84	88	126
18	9	5	1.1	43	40	25	4
19	71	15	1.6	195	52	15	11
20	13	6	2.1	701	73	20	4
21	39	17	1.1	743	24	17	105
41	24	25	ND	372	22	16	7
42	21	25	ND	409	280	17	6
56	28	15	ND	336	41	37	10
57	62	32	11.4	361	21	15	207
Mean	41	20	5	377	59	46	70
EPA	7	23	2.3	454		9	68
WHO	49	23	9.8	272	82	138	14
% Over	33	28	0.0	22	17	0	33

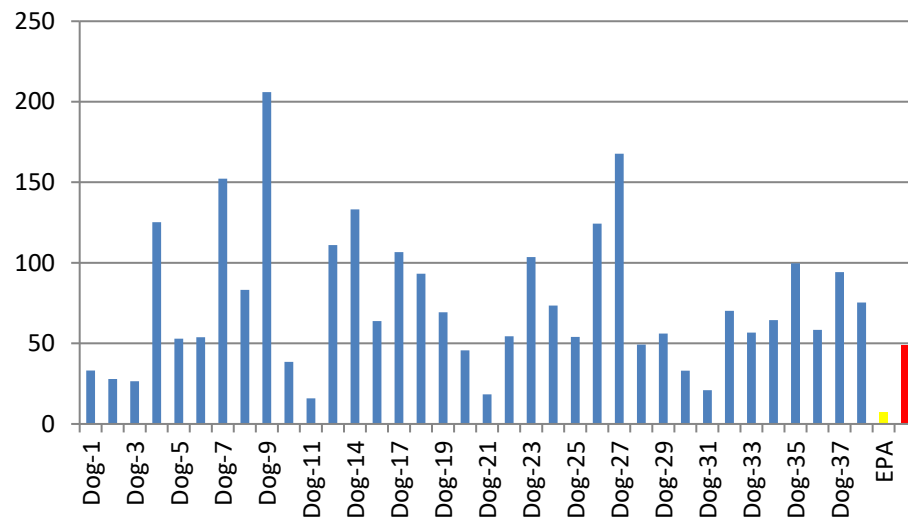
	As	Cd	Hg	Ni	Pb	Sb	U
Dog-1	33	9	0.1	763	32	5	15
Dog-2	28	8	ND	442	19	2	28
Dog-3	26	16	ND	351	17	2	21
Dog-4	125	10	1.1	416	38	2	9
Dog-5	53	16	1.3	404	119	16	7
Dog-6	54	16	1.0	626	155	18	10
Dog-7	152	14	0.8	645	37	7	46
Dog-8	83	25	0.1	635	46	13	216
Dog-9	206	11	1.8	361	54	4	34
Dog-10	39	10	ND	846	47	48	58
Dog-11	16	5	ND	821	20	3	4
Dog-12	111	11	0.3	354	40	8	34
Dog-14	133	42	0.4	583	154	15	280
Dog-15	64	21	ND	408	69	8	166
Dog-17	107	12	0.5	349	43	4	16
Dog-18	93	10	0.2	345	44	8	4
Dog-19	69	13	0.0	371	25	9	95
Dog-20	46	26	ND	504	25	6	90
Dog-21	18	ND	0.3	339	14	3	33
Dog-22	54	11	0.1	446	41	4	103
Dog-23	104	21	ND	390	34	8	456
Dog-24	73	16	ND	556	55	8	192
Dog-25	54	12	ND	369	45	5	236
Dog-26	124	16	0.1	319	33	7	322
Dog-27	168	15	0.5	309	37	9	510
Dog-28	49	14	ND	405	73	5	9
Dog-29	56	18	ND	402	72	4	7
Dog-30	33	25	ND	590	80	5	5
Dog-31	21	40	0.1	632	20	3	4
Dog-32	70	27	0.2	474	23	1	5
Dog-33	57	14	0.4	609	52	96	4
Dog-34	64	11	ND	499	38	2	8
Dog-35	100	17	ND	812	76	5	19
Dog-36	58	22	0.2	1764	97	5	14
Dog-37	94	28	0.1	1067	28	8	321
Mean	75	17	0.5	549	51	10	97
EPA	7	23	2.3	454		9	68
WHO	49	23	9.8	272	82	138	14
% Over	70	19	0.0	46	11	0	32

	As	Cd	Hg	Ni	Pb	Sb	U
2009 % Over	33	28	0	22	17	0	33
2019 % Over	70	19	0	46	11	0	32

As 2009 (ug/3 cups)



As 2019 (ug/3 cups)



Element	EPA Human RfD (µg/kg/day)	EPA Human RfD (per 10 lbs body weight)	WHO Human TDI (µg/kg/day)	WHO Human TDI (per 10 lbs body weight)
As	0.3	1.4	2.14	9.72
Be	2	9	-	-
Cd	1	4.5	1	4.5
Hg	0.1	0.5	from 0.4 to 2 µg /kg/day depending on type of Hg and literature source	1.82 (based on 0.4 µg /kg/day)
Ni	20	91	12	55
Pb	-	-	3.6	16
Sb	0.4	1.8	6	27
Tl	0.1	0.5	-	-
U	3	14	0.6	2.7

ID#	As	Cd	Hg	Ni	Pb	Sb	U
46	4.5	2.5	0.1	134	6.5	7.4	0.9
14	6.7	1.9	0.3	55	354.6	11.3	13.6
40	6.5	1.9	0.1	191	7.0	1.9	3.7
47	7.2	1.9	0.0	135	9.3	1.5	2.1
49	8.2	2.3	0.3	182	9.1	2.3	1.1
6	9.7	2.5	0.6	43	24.4	4.4	1.0
50	7.2	2.6	0.3	75	12.7	4.6	1.7
48	13.6	4.2	0.0	91	12.1	3.1	1.3
7	8.1	3.2	0.3	63	4.5	1.9	0.9
8	7.1	1.7	0.4	40	7.3	22.2	0.4
43	17.6	2.9	0.5	87	11.3	8.6	1.5
13	16.5	2.8	3.7	34	7.1	25.8	0.8
Mean	9	3	1	94	39	8	2
EPA	1	4.5	1	91	-	2	14
WHO	10	4.5	2	55	16	27	3
2009 % Over	25	0.0	8	33	17	0	0

- 2009
 - High Pb, Ni
 - Little to no: Hg, U, Sb, Cd

ID	As	Cd	Ni	Pb	Sb	U
Cat-1	5.0	1.0	92	9.1	0.3	ND
Cat-2	34.7	2.4	120	11.7	ND	0.2
Cat-3	40.4	4.0	91	11.7	ND	0.6
Cat-4	5.7	5.4	110	1.6	ND	1.4
Cat-5	7.4	ND	35	4.7	0.6	ND
Cat-6	11.5	5.1	80	17.2	2.7	25.4
Cat-7	4.8	2.7	50	8.3	1.1	16.1
Cat-8	13.4	6.1	60	12.9	1.8	29.2
Cat-9	2.5	2.0	81	14.5	1.3	0.2
Cat-10	5.7	2.8	71	12.3	0.8	15.8
Cat-11	10.5	0.9	99	18.2	0.4	ND
Cat-12	16.2	2.4	93	7.8	0.2	1.5
Cat-13	13.4	2.0	85	14.9	0.3	ND
Cat-14	3.9	2.2	119	5.1	0.6	4.7
Cat-15	24.2	1.7	102	10.0	0.9	0.0
Cat-16	8.4	1.8	109	6.5	0.1	7.5
Cat-17	2.0	0.7	94	3.9	0.0	0.1
Cat-18	6.0	0.6	123	6.4	0.0	0.6
Cat-19	25.8	1.3	119	12.4	0.3	1.1
Cat-20	29.1	2.1	99	12.4	ND	0.2
Cat-21	8.6	0.3	52	3.2	ND	0.2
Cat-22	27.3	1.1	134	10.5	0.1	4.7
Cat-23	6.2	2.3	174	13.1	0.8	0.3
Cat-24	26.2	4.1	399	43.4	1.8	0.5
Cat-25	9.2	3.8	198	4.9	0.4	0.3
Mean	14	2	112	11	1	5
EPA	1	4.5	91	-	2	14
WHO	10	4.5	55	16	27	3
2019 % Over	48	12.0	68	12	0	16

- 2009
 - High Pb, Ni
 - Little to no: Hg, U, Sb, Cd

- 2019
 - High As; most samples
 - High Ni
 - Some U above limit
 - Pb dropped

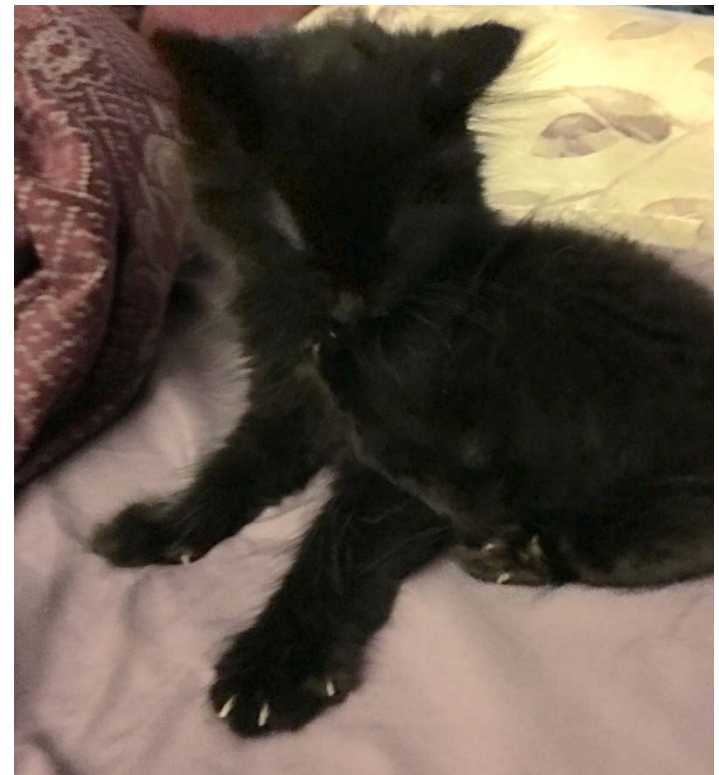
	As	Cd	Ni	Pb	Sb	U
2009 Mean	9	3	94	39	8	2
2009 % Over	25	0.0	33	17	0	0
2019 Mean	14	2	112	11	1	5
2019 % Over	48	12.0	68	12	0	16

- 2009
 - High Pb, Ni
 - Little to no: Hg, U, Sb, Cd
- 2019
 - High As; most samples
 - High Ni
 - Some U above limit
 - Pb dropped



- Ten years has not made a big difference on overall heavy metal levels in pet food
- Some Pb has dropped but As and U were increased
- First time seeing U in Cat food
- No limits set by FSMA for heavy metals in pet food
- Few limits set in human food as well

- Thanks to all the employees of SPEX CertiPrep, SamplePrep & CEM and their pets for the donation of pet food
- Bill Driscoll, ICP-MS Chemist, SPEX CertiPrep
- Eric Smith, SPEX SamplePrep
- Bob Lockerman, CEM
- Tina Restivo, CEM



This study is not a comprehensive study of all potential contaminants found in pet foods.

The random samples tested were deemed to be snapshots of the overall levels of toxic elements that could be consumed by pets.

SPEX CertiPrep & CEM make no medical or veterinary claims as to the hazardous nature of any particular compound or pet food.

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Questions?