

# Evaluation of Microbial Populations in Raw Meat Diets Fed to Captive Exotic Animals in Zoological Institutions

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### Summary and Implications

The objective of this study was to evaluate general microbial population levels of common raw meat diets fed to exotic carnivores managed in zoos. Four raw meat diet formulations were sampled and analyzed for generic *E.coli*, total coliforms, yeast, mold, *Staphylococcus aureus*, total aerobic plate counts and presence of *Salmonella*. Each product was sampled at least three times between 2012 and 2015 and descriptive statistics are presented. Ranges were extreme even among the same diet type. *Salmonella* species tested presumptive positive in nearly 50% of samples from three of the diets. Additional research is required to identify specific serotypes of *Salmonella* present.

### Introduction

Feeding carnivores raw meat diets formulated to meet the nutrient requirements of domestic dogs and cats is common practice in zoological institutions. Over the past several years, feeding raw meat diets also has become increasingly popular in the companion animal industry. Formulated, nutritionally complete raw meat diets have been shown more highly digestible than cooked or processed diets but there is reluctance to feed raw diets because of microbial and parasitic concerns associated with raw meat. These concerns may be mitigated with proper handling and storage of raw meat, outlined by the USDA, but microbial levels may still remain naturally high. The ability of cats and dogs (exotic and domestic), to remain asymptomatic after consuming raw meat suggests they tolerate high numbers of microorganisms in their diets. Short intestinal tracts and fast transit times likely limit the opportunity for pathogens to colonize in the gastrointestinal tract that cause clinical symptoms. There are no published regulations or recommendations for allowable microbial levels in raw meat diets for zoo carnivores. The objective of this study was to evaluate general microbial population levels in four common raw meat diets fed to zoo-managed carnivores.

### Methods and Materials

Diets were obtained from Omaha's Henry Doorly Zoo and Aquarium (OHDZA) during 2012 – 2015. Four different commercially available diets, formulated to meet

the nutrient requirements of cats were evaluated and included one beef-based (Nebraska Brand®, North Platte, NE, USA: Special Beef Feline Diet (Beef)), one pork-based (Sustainable Swine Resources, LLC, Sheboygan Falls, WI, USA: Carnivore Essentials (Pork)), and two horse-based ((Nebraska Brand®, North Platte, NE, USA: Premium Feline Diet (Horse1)), (Nebraska Brand®, North Platte, NE, USA: Classic Bird of Prey Diet (Horse2)). Samples were obtained from product thawed under refrigeration from the center of 5.0 Lb tubes. Microbial evaluations were conducted at Midwest Laboratories [(Omaha, NE) ((Method 991.14) AOAC, 1994); ((Method 2003.07) AOAC, 2003); (FDA/BAM, 2001b); (FDA/BAM, 2001a)]. Microbial evaluation included: colony forming units (cfu) per gram of *Escherichia coli* (*E. coli*), total coliforms, yeast, mold, *Staphylococcus aureus*, aerobic plate count (APC), and presence of *Salmonella*.

### Results and Discussion

Results presented represent average microbial counts that were collected from the OHDZA samples. Microbial counts were high and variable between and within diets. There was greater than a 98% difference between Horse1 and Horse2 regarding APC and total coliforms. There also was considerable variation of microbial population within samples over time. For example, *E. Coli* ranged from 90 to 86,000 cfu in the beef diet in the lowest and highest sampling, respectively. Very large standard deviations (SD) also indicate large variation within the diet type. With this variation over time, it is important to recognize microbial populations will vary from lot to lot, particularly without having undergone some form of microbial intervention such as High Pressure Pasteurization (HPP). Three of the diets (Beef, Pork, Horse2) tested presumptive positive for *Salmonella* in 39, 33 and 75% of samples, respectively. Microbial evaluations in this study for *Salmonella* and *E. coli* strictly indicated mere presence of any serotype of each pathogen, only a handful of which are pathogenic. For this reason, high levels of cfu for *E. coli* and presumptive positive *Salmonella* results do not inherently mean a diet is dangerous to the consuming animal. Clinical symptoms (vomiting, diarrhea, lethargy, lack of diet consumption, lameness) and disease related to pathogenic microbes were not reported in animals fed any of the diets sampled during the data collection period. In conclusion, microbial loads are undoubtedly high and variable in raw meat diets. Additional research is warranted to serotype specific *Salmonella* found in the diets. Additional pathogens of significance should be isolated and considered including *Shigella*, *Listeria*, *Campylobacter* and *Clostridia*. Additionally, institutions should develop appropriate and

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acceptable ranges for raw meat diets coming into their facilities.

### Acknowledgements

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**Table 1: Average microbial population counts ((cfu/g) ± SD) of raw meat diets fed to zoo managed carnivores <sup>1,2</sup>**

Microbe	Beef (n=23)	Pork (n=3)	Horse1 (n=7)	Horse2 (n=8)	Mean	Median	Min- Max
E. Coli (generic)	8,086±19,971	1,360±2,202	59±151	21,674±59,127	8,464±29,050	530	n.d.- 168,000
Total Coliforms	8,665±17,967	4,053±4,873	907±986	48,394±133,187	14,201±58,437	1,290	n.d.- 378,000
Yeast	4,310±10,478	83±78	127±169	2,538±2,871	2,863±7,861	480	n.d.- 48,500
Mold Count	263±1,081	7±12	7±8	910±631	313±880	10	n.d.- 5,200
Staphylococcus aureus	0.22±1.04	n.d	n.d	n.d	0.12±0.76	n.d	n.d.-5
APC	3.83x10 <sup>6</sup> ±8.20x10 <sup>6</sup>	2.79x10 <sup>4</sup> ±1.3x10 <sup>4</sup>	7.71x10 <sup>3</sup> ±7.48x10 <sup>3</sup>	2.24x10 <sup>7</sup> ±5.88x10 <sup>7</sup>	6.83x10 <sup>6</sup> ±2.62x10 <sup>7</sup>	3.90x10 <sup>5</sup>	760- 1.68x10 <sup>8</sup>

<sup>1</sup> Abbreviations used: APC, Aerobic plate count; cfu, colony-forming units; SD, standard deviation; n.d., non-detectable

<sup>2</sup> Reporting limits: E. Coli=10, Total Coliforms=10, Yeast=10, Mold Count=10, Staphylococcus aureus=10

**Figure 1. Percent of raw meat diets fed to zoo carnivores that tested “Presumptive Positive” for Salmonella species (reporting limit: 1 organism per 25 grams of sample)**

