

Safer Raw Pet Food with E-Beam Technology

It is no secret that raw pet food has experienced explosive growth in recent years and has become a popular option for many pet parents. Sales of freeze-dried raw and air-dried pet foods have increased by 240% over the last five years, and an estimated 14% of cat owners & 19% of dog owners have now added raw foods to their animals' routines.

And who can blame them? According to several studies, raw diets are [easier to digest](#)¹, provide more metabolically “usable” [energy](#)², promote a healthier [body weight](#)³, and more directly mirror the foods cats and dogs [naturally seek out](#)⁴.

Unfortunately, processing methods used to ensure pet-food safety are not foolproof. The environments where both human and pet-food ingredients are grown and processed, even in ideal circumstances, can be common sources of pathogenic contamination from bacteria, viruses, or parasites. This contamination can occur at the absolute best and cleanest farms, feedlots, processing centers, and slaughterhouses before the ingredients even arrive at pet-food facilities.

So, what is a health-conscious pet parent to do?

Carnivore Meat Company recently collaborated with Texas A&M University to validate an approach that has been used in the human food industry for decades but that is currently novel in the pet-food space—electron-beam (or E-Beam) technology. This white paper will first examine why such a “kill step” is the best approach and then dive into whether E-Beam can eliminate foodborne pathogens safely, effectively, and consistently, without compromising on the quality and nutrition while keeping foods raw.

¹ K. R. Kerr, B. M. Vester Boler, C. L. Morris, K. J. Liu, K. S. Swanson, Apparent total tract energy and macronutrient digestibility and fecal fermentative end-product concentrations of domestic cats fed extruded, raw beef-based, and cooked beef-based diets, *Journal of Animal Science*, Volume 90, Issue 2, February 2012, Pages 515–522, doi.org/10.2527/jas.2010-3266

² Elizabeth L Geary, Carl M Parsons, Pamela L Utterback, James Templeman, Kelly S Swanson, PSVIII-18 Standardized Amino Acid Digestibility and Nitrogen-Corrected True Metabolizable Energy of Frozen Raw, Freeze-Dried Raw, Fresh, and Extruded Dog Foods Using Cecectomized and Conventional Rooster Assays, *Journal of Animal Science*, Volume 101, Issue Supplement_3, November 2023, Pages 462–463, doi.org/10.1093/jas/skad281.549

³ Thunyakorn Phungviwatnikul, Anne H Lee, Sara E Belchik, Jan S Suchodolski, Kelly S Swanson, Weight loss and high-protein, high-fiber diet consumption impact blood metabolite profiles, body composition, voluntary physical activity, fecal microbiota, and fecal metabolites of adult dogs, *Journal of Animal Science*, Volume 100, Issue 2, February 2022, skab379, doi.org/10.1093/jas/skab379

⁴ Hewson-Hughes, A. K., Hewson-Hughes, V. L., Colyer, A., Miller, A. T., McGrane, S. J., Hall, S. R., Butterwick, R. F., Simpson, S. J., & Raubenheimer, D. (2013). Geometric analysis of macronutrient selection in breeds of the domestic dog, *Canis lupus familiaris*. *Behavioral ecology: official journal of the International Society for Behavioral Ecology*, 24(1), 293–304. doi.org/10.1093/beheco/ars168

How Prevalent and Problematic Are Foodborne Pathogens in Pet Food?

The answer is different than one might think.

Despite the pet-food industry's best efforts, product recalls occur across food types including kibble, wet foods, treats, raw foods, and more. True, dogs and cats have evolved to fight off these pathogens more effectively than humans; their digestive tracts are both shorter and more acidic, giving harmful microbes less time to infect the host and a less hospitable environment in which to reproduce. Even so, [the CDC warns](#)⁵ that contaminated food—whether cooked or raw—can still sicken these pets and the owners who care for them.

Not even conventional methods of eliminating pathogens do so perfectly. According to the FDA, [48 recalls were issued](#)⁶ for pet-food products between January 2019 and February 2026 alone, with over half attributed to potential foodborne-pathogen contamination. And the threat is not just to animals' health. The [National Center for Biotechnology Information](#)⁷ (NCBI) warns that contaminated pet food is “increasingly recognized as a significant vehicle for the transmission of foodborne pathogens to humans.”

Pet parents often share living spaces with their pets and frequently handle their food with bare hands. Very young children are often in close and direct proximity to pet-food bowls. Of the 117 pet-food recalls due to *Salmonella* spp. in the last 25 years, [at least 11 were linked to human outbreaks](#)⁸. One such outbreak sickened [seven people](#)⁹, six of whom were infants under a year old.

Salmonella spp., *L. monocytogenes* (commonly known as *Listeria*), and other foodborne pathogens have the potential to make humans very ill, potentially leading to death. This is especially applicable to young children, elderly adults, pregnant women, and the immunocompromised. And because young children in particular are likely to play closely with

⁵ U.S. Centers for Disease Control, “About Pet Food Safety,” 2025, www.cdc.gov/healthy-pets/about/pet-food-safety.html

⁶ U.S. Food and Drug Administration, “Recalls & Withdrawals,” 2026, www.fda.gov/animal-veterinary/safety-health/recalls-withdrawals

⁷ Dhakal, J., Cancio, L. P. M., Deliephan, A., Chaves, B. D., & Tubene, S. (2024). *Salmonella* Presence and Risk Mitigation in Pet Foods: A Growing Challenge with Implications for Human Health. *Comprehensive reviews in food science and food safety*, 23(6), e70060. doi.org/10.1111/1541-4337.70060

⁸ Dhakal, J., Cancio, L. P. M., Deliephan, A., Chaves, B. D., & Tubene, S. (2024). *Salmonella* Presence and Risk Mitigation in Pet Foods: A Growing Challenge with Implications for Human Health. *Comprehensive reviews in food science and food safety*, 23(6), e70060. doi.org/10.1111/1541-4337.70060

⁹ U.S. Food and Drug Administration, “FDA and CDC Investigate Cases of *Salmonella* Linked to Pet Food Made by Mid America Pet Food; Multiple Brands Recalled,” 2024, www.fda.gov/animal-veterinary/outbreaks-and-advisories/fda-and-cdc-investigate-cases-salmonella-linked-pet-food-made-mid-america-pet-food-multiple-brands

animals, not wash up after being licked, be incautious about feces, and even try pet foods themselves, they are particularly at risk of infection.

How Do We Address Such a Problem?

The FDA's Food Safety Modernization Act, enacted in 2011, helped standardize the industry's approach to addressing hazards that have the potential to impact human or animal health. The guidance helps food and ingredient manufacturers up and down the supply chain consider the potential severity of each identified hazard, combined with the likelihood of its occurrence. When the severity and likelihood are both high, the manufacturer or supplier must take steps to control the hazard. When the hazard is a living organism (like a bacteria) that step is commonly referred to as a "kill-step." In some pet-food types, the necessary kill step is built into the process. Cooked pet foods, for example, are often baked or extruded. Unfortunately, the same heat-treating methods that destroy or deactivate pathogens can also reduce the quality and availability of certain nutrients. Raw pet foods aim to keep texture, quality, and nutritional profiles nearer to dogs' and cats' ancestral diets. However, not cooking these foods leaves them without a built-in kill step.

The purpose of this white paper is to demonstrate that E-Beam, the kill step selected for and used by Carnivore Meat Company, is the safest and most consistent way to ensure safety without compromising quality.

What Is E-Beam?

E-Beam technology is a fast, chemical-free, non-thermal [FDA](#)¹⁰ and USDA-approved approach to ensuring the safety of foods and their packaging materials. E-Beam uses electricity to generate and excite electrons and then focuses those electrons into a beam that can interact with materials in specific ways. In a food-safety context, that beam passes through foods and destroys the DNA of any resident microbes, rendering them incapable of reproducing.

E-Beam is a form of ionizing radiation, or "irradiation." However, it differs from other kinds of irradiation in that no part of the E-Beam process uses or produces radioactive material. E-Beam does not expose foods to radioactivity, and it cannot cause foods to become radioactive in any way.

¹⁰ U.S. Food and Drug Administration, "Food Irradiation: What You Need to Know," 2024, www.fda.gov/food/buy-store-serve-safe-food/food-irradiation-what-you-need-know



Backed by over [a hundred years](#)¹¹ of research and development, E-Beam has been approved for use in pet food since 2001. E-Beam is used to disinfect, decontaminate, or pasteurize [hundreds of millions of pounds of human foods](#)¹² across more than 40 categories¹³ including meats, fresh produce, and spices. Such applications are common in over 60 countries¹⁴, including the United States, the European Union, China, and Australia. Additionally, the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and the U.S. Department of Agriculture (USDA) have also approved the use of irradiation for animal and human food.

The Testing Process

With E-Beam proven effective in human-food applications, Carnivore Meat Company, the manufacturer of Vital Essentials, sought to validate its use in pet food as well. This study examined the effects of E-Beam technology on various raw pet-food ingredients and products, aiming to identify how effectively E-Beam deactivates pathogens and what side effects might exist.

Multiple samples of the following raw meat-based pet-food products were tested:

- Frozen Pork Patty Formula
- Freeze-Dried Cubed Beef Liver
- Freeze-Dried Salmon Skin
- Freeze-Dried Whole Chicken Hearts
- Freeze-Dried Whole Minnows
- Freeze-Dried Duck Small Nib Formula
- Freeze-Dried Ground Chicken Formula
- Freeze-Dried Pork Patty Formula

The study included four steps, described below. The initial two were preparatory, aimed at verifying the efficacy of the intended testing method. The third task was to carry out that method and record its results. The fourth task was to use a Geiger counter to verify that the

¹¹ Food Safety Magazine, "Electron Beam Technology: A Platform for Safe, Fresh, and Chemical-Free Food," 2018, www.food-safety.com/articles/5791-electron-beam-technology-a-platform-for-safe-fresh-and-chemical-free-food

¹² R. Eustice, Food Irradiation: A Global Perspective & Future Prospects (2011), *American Nuclear Society- Nuclear Newswire*, www.ans.org/news/article-733/food-irradiation-a-global-perspective-future-prospects/

¹³ Food Safety and Inspection Service, U.S. Department of Agriculture, "Irradiation and Food Safety FAQ," 2024, www.fsis.usda.gov/food-safety/safe-food-handling-and-preparation/food-safety-basics/irradiation-and-food-safety-faq

¹⁴ International Atomic Energy Agency, "Food Irradiation," www.iaea.org/topics/food-irradiation



E-Beam-treated products showed no signs of radioactivity. As indicated above, E-Beam does not and cannot produce radioactivity, but because some consumers hold a misconception to the contrary, this step was included to address those concerns.

Task 1: Dose-Mapping to Ensure Consistent Dose Distribution.

The first preparatory task was to determine whether the E-Beam setup would treat each test sample evenly, like ensuring that a microwave has no “hot spots.”

To begin, 25 grams of each sample were packaged, and alanine pellets were placed at regular intervals across the sample’s surface to function as dosimeters (i.e., instruments for measuring the E-Beam “dose” administered). The samples were then placed on a conveyor belt and carried through the E-Beam system.

Following treatment, the alanine pellets were tested using a Bruker Scan ESR spectrometer, and the results were used to calculate the Dose Uniformity Ratio (DUR). The goal was to reach a DUR of close to 1.0, which would indicate that the E-Beam was distributing electrons consistently across the surface of a sample. This goal was achieved, as seen in Figure 1.

Figure 1. Absorbed E-Beam Doses and Dose Uniformity Ratio (DUR)			
Sample	Minimum Absorbed Dose (D_{min}) (kGy)	Maximum Absorbed Dose (D_{max}) (kGy)	Dose Uniformity Ratio (DUR)
Frozen Pork Patty Formula	0.89	0.94	1.05
Freeze-Dried Cubed Beef Liver	0.79	0.88	1.11
Freeze-Dried Salmon Skin	0.84	0.95	1.13
Freeze-Dried Whole Chicken Hearts	0.86	0.93	1.08
Freeze-Dried Whole Minnows	0.87	0.93	1.07
Freeze-Dried Duck Small Nib Formula	0.89	0.94	1.06
Freeze-Dried Ground Chicken Formula	0.85	0.9	1.06
Freeze-Dried Pork Patty Formula	0.88	0.93	1.06

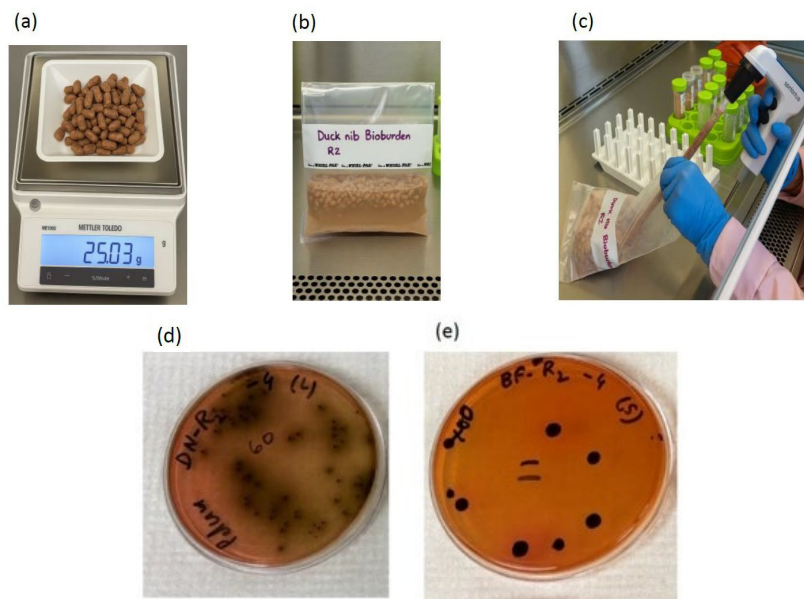
Task 2: Standardizing Inoculation and Recovery Procedures.

The second preparatory task was to ensure that the handling of samples resulted in minimal bacterial losses, and that pathogens applied to each sample could be effectively recovered and counted. This was a crucial step, establishing that if bacteria numbers decreased following E-Beam treatment, this would be due to the treatment and not other routine handling.

First, each freeze-dried and frozen raw meat-based pet food was tested for background (i.e., already existing) *L. monocytogenes*, *Salmonella* spp., and general aerobic bacteria. As expected, and typical of any raw food product, aerobic bacteria counts were generally high; however, no *L. monocytogenes* or *Salmonella* spp. contamination was detected.

Second, the freeze-dried and frozen raw meat-based pet foods were inoculated. Predetermined amounts of *L. monocytogenes* and *Salmonella* spp. were applied to, and mixed with, the samples. Bacterial samples were then taken from the inoculated raw meat-based pet-food products and cultured on appropriate growth media in petri dishes, and the resulting colonies were counted the next day. (See Figure 2.)

Figure 2. Microbial Testing Process



Sample-processing steps for microbial-recovery testing included a) weighing the sample, b) spiking and homogenizing the sample, c) extracting the sample, d) counting *L. monocytogenes* colonies, e) counting *Salmonella* spp. colonies, f) counting general aerobic bacteria colonies.

Universally, the number of bacteria recovered after inoculation was slightly lower than, but reasonably close to, the amount of bacteria originally applied. This result demonstrates that the above method achieves effective bacterial recovery with minimal handling losses.

Task 3: Treating the Samples with E-Beam Technology and Identifying Remaining Microbial Load.

After the above preparatory steps concluded, the main task began.

The samples were inoculated and packaged as described in Tasks 1 and 2. They were then sent via the conveyor belt and treated by the E-Beam. Eighteen different samples of each pet food product were tested, with three samples being tested at each of six E-Beam doses: 0 kGy (as a control), 2.5 kGy, 4 kGy, 7 kGy, 12 kGy, and 25 kGy. The alanine-pellet dosimeters confirmed these doses as accurate and consistently applied.

The bacterial survival rates were then compared across the varying E-Beam doses, and reductions in microbial colonies were calculated relative to the control (0 kGy-treated) samples.

Ultimately, E-Beam was determined to be a highly effective way to destroy harmful pathogens. As indicated in Figure 3, all *L. monocytogenes* and *Salmonella* spp. populations were reduced below detectable numbers after an E-Beam dose of 2.8–7.3 kGy.

Figure 3. Microbial Reduction vs kGy Results			
	Reduction in <i>Salmonella</i> spp.		
	Population at 0 kGy (log CFU/25g)	Limit of Detection (log CFU/25g)	Dose to Reduce Populations below Detectable Numbers (kGy)
Frozen Pork Patty Formula	8.5	1.7	3.5
Freeze-Dried Pork Patty Formula	7.3	1.7	7.3
Freeze-Dried Cubed Beef Liver	7.5	1.6	6.3
Freeze-Dried Salmon Skin	6.0	1.4	2.8
Freeze-Dried Whole Chicken Hearts	6.5	1.5	4.3
Freeze-Dried Duck Small Nib Formula	5.1	1.4	4.2
Freeze-Dried Ground Chicken Formula	5.1	1.7	6.7
Freeze-Dried Whole Minnows	6.6	1.3	7.2
	Reduction in <i>L. monocytogenes</i>		
	Population at 0 kGy (log CFU/25g)	Limit of Detection (log CFU/25g)	Dose to Reduce Populations below Detectable Numbers (kGy)

Freeze-Dried Pork Patty Formula	7.4	1.7	6.4
Freeze-Dried Pork Patty Formula	7.8	1.7	4.2
Freeze-Dried Cubed Beef Liver	7.6	1.6	6.3
Freeze-Dried Salmon Skin	6.4	1.4	2.8
Freeze-Dried Whole Chicken Hearts	6.9	1.5	4.3
Freeze-Dried Duck Small Nib Formula	7.6	1.4	7.1
Freeze-Dried Ground Chicken Formula	7.8	1.7	3.9
Freeze-Dried Whole Minnows	7.4	1.3	7.2

The composition and texture of samples seemed to affect how large a dose was required. Some samples, such as Freeze-Dried Salmon Skin and freeze-dried chicken hearts, required less than 3 kGy to achieve complete microbial deactivation. Regardless of sample type, it was shown that a low to moderate E-Beam dose would reduce microbial presence by at least 99.999%.

Task 4: Checking the E-Beam-Treated Samples with a Geiger Counter to Confirm No Radiation Was Generated.

After one hundred years of study, E-Beam technology is well established as being safe because it is incapable of generating or transferring radioactivity. However, because of a pervasive myth that food irradiation results in radioactivity, this study included a phase for testing each sample with a Geiger counter before and after treatment. The ambient radiation levels at the two Texas A&M testing facilities used for this study (identified as “Microbial Lab” and “E-Beam Center” in Figure 4 below) were also measured to determine the location’s natural effect on food-sample readings.

For context, a [Geiger counter will never read “0”](#)¹⁵ anywhere on Earth. Some amount of radiation is normal, as radiation is emitted by plants, animals, household items like computers, the sun, stones like granite, and more. This normal background level of radiation is variable and exponentially lower than the levels known to cause harm in humans and animals.

As expected, the radiation levels in the samples, both before and after E-Beam exposure, did not exceed normal background levels (See Figure 4). In fact, they read at roughly one-third to one-half of the average background radiation levels in the United States and less than one-tenth the level considered medically concerning.

¹⁵ The Health Physics Society (2024, December) PDF document, "Common sources of radiation fact sheet", https://wp-content/uploads/2024/12/background_radiation_fact_sheet.pdf

Figure 4. Geiger-Counter Readings before and after E-Beam Treatment (mR/hr)

	Min.	Max.
Occupational Radiation Exposure Limit (Annual)	2,000*	2,000*
Environmental/Background Radiation—USA Average	0.03**	0.03**
Environmental/Background Radiation—Microbial Lab	0.01	0.01
Environmental/Background Radiation—E-Beam Center	0.01	0.02
Test Product—Background Radiation—Before Treatment—Microbial Lab	0.01	0.01
Test Product—Background Radiation—Before Treatment—E-Beam Center	0.01	0.01
Test Product—After Treatment—0 kGy	0.01	0.01
Test Product—After Treatment—2.5 kGy	0.01	0.01
Test Product—After Treatment—4.0 kGy	0.01	0.02
Test Product—After Treatment—7.0 kGy	0.01	0.01
Test Product—After Treatment—12.5 kGy	0.01	0.02
Test Product—After Treatment—25.0 kGy	0.01	0.02
*International Commission on Radiological Protection exposure limit, per year.		
**USA hourly average given for both minimum and maximum values, per the Radwatch team at UC Berkeley (https://radwatch.berkeley.edu/dosenet/).		

Ultimately, testing showed no correlation between the strength of an E-Beam dose and any detected radiation, with values remaining within normal background Geiger readings.

How Does E-Beam Compare to Other Kill Steps?

As indicated above, untreated raw pet foods that have no built-in kill step remain at a higher risk of microbial contamination when compared to other, more traditionally processed pet foods.

Indeed, [studies](#)¹⁶ reviewing the safety of raw pet foods found that 7–16% tested positive for *L. monocytogenes* and *Salmonella* spp. A [comprehensive study in the United Kingdom](#)¹⁷—in which

¹⁶ Nemser, S. M., Doran, T., Grabenstein, M., McConnell, T., McGrath, T., Pamboukian, R., Smith, A. C., Achen, M., Danzeisen, G., Kim, S., Liu, Y., Robeson, S., Rosario, G., McWilliams Wilson, K., & Reimschuessel, R. (2014). Investigation of *Listeria*, *Salmonella*, and toxigenic *Escherichia coli* in various pet foods. *Foodborne pathogens and disease*, 11(9), 706–709. doi.org/10.1089/fpd.2014.1748

U.S. Food and Drug Administration, “Get the Facts! Raw Pet Food Diets can be Dangerous to You and Your Pet,” 2018, www.fda.gov/animal-veterinary/animal-health-literacy/get-facts-raw-pet-food-diets-can-be-dangerous-you-and-your-pet#study

¹⁷ Jorgensen, F., Kesby, M., Aranega-Bou, P., Willis, C., Aird, H., Lai, S., Fearnley, C., Abu Oun, M., Puddicombe-Coles, B., Swift, C., Douglas, A., Hopkins, K., Chattaway, M., Couzens, C., Corcionivoschi, N., & Sprekelsen, D. (2026). A survey of microbiological and antimicrobial resistance (AMR) contamination found in raw dog and cat food on retail sale in the UK. *FSA Research and Evidence*. doi.org/10.46756/001c.155340

380 samples of raw, commercially produced pet foods were tested—found harmful bacteria in 35%. And a Cornell University study found pathogens in a concerning 42% of commercially produced raw cat foods.¹⁸

To complicate the matter, [a separate study](#)¹⁹ found that only half of dogs infected with *Salmonella* spp. exhibited signs of illness—meaning that a pet could be carrying a pathogen without its owner even realizing it. Additionally, [one study](#)²⁰ indicated that dogs fed raw-food diets are 23 times more likely to shed *Salmonella* spp. than those fed cooked diets, and [another indicated](#)²¹ that some dogs exposed to *Salmonella* spp. can shed the pathogen for up to a week afterward.

With this in mind, the pet-food industry has devised a number of methods to solve this problem, to varying degrees of efficacy, which we will discuss below.

Probiotics

Some companies fearful of more traditional kill-step methods have implemented probiotics as a pathogen-control method. Probiotics (live bacteria or yeasts considered to have beneficial effects on the body) are applied to raw foods, where they then compete with existing microbiota, including pathogens, for resources, theoretically crowding out dangerous microbes.

While probiotics have been studied for health benefits, some regulatory authorities are concerned about the effectiveness of this method. It has also been associated with at least [one recall](#)²².

¹⁸ Heinze, C. (2025). Raw Pet Food Risks: A Research Update. *Tufts University PetFoodology*. sites.tufts.edu/petfoodology/2025/10/27/raw-pet-food-research-update/

¹⁹ Reimschuessel, R., Grabenstein, M., Guag, J., Nemser, S. M., Song, K., Qiu, J., Clothier, K. A., Byrne, B. A., Marks, S. L., Cadmus, K., Pabilonia, K., Sanchez, S., Rajeev, S., Ensley, S., Frana, T. S., Jergens, A. E., Chappell, K. H., Thakur, S., Byrum, B., Cui, J., Okwumabua, O. (2017). Multilaboratory Survey to Evaluate Salmonella Prevalence in Diarrheic and Nondiarrheic Dogs and Cats in the United States between 2012 and 2014. *Journal of clinical microbiology*, 55(5), 1350–1368. doi.org/10.1128/JCM.02137-16

²⁰ Giacometti, F., Magarotto, J., Serraino, A., & Piva, S. (2017). Highly suspected cases of salmonellosis in two cats fed with a commercial raw meat-based diet: health risks to animals and zoonotic implications. *BMC veterinary research*, 13(1), 224. doi.org/10.1186/s12917-017-1143-z

²¹ Dhakal, J., Cancio, L. P. M., Deliephan, A., Chaves, B. D., & Tubene, S. (2024). Salmonella Presence and Risk Mitigation in Pet Foods: A Growing Challenge with Implications for Human Health. *Comprehensive reviews in food science and food safety*, 23(6), e70060. doi.org/10.1111/1541-4337.70060

²² U.S. Food and Drug Administration, “ANSWERS Pet Food Voluntarily Withdrawals Certain Limited Lots of Beef and Chicken Dog Foods Due to Potential Salmonella and Listeria”, 2024, www.fda.gov/safety/recalls-market-withdrawals-safety-alerts/answers-pet-food-voluntarily-withdrawals-certain-limited-lots-beef-and-chicken-dog-foods-due

Bacteriophages

Other companies have applied bacteriophages (essentially viruses that target specific pathogens) across their foods.

While some consider bacteriophages a “natural” approach to food safety, they have limitations. First, they are only effective against their targeted pathogens, leaving others to grow unchecked. Second, the bacteriophage mixture must be completely blended throughout the food for treatment to be effective. This process is difficult to achieve consistently in an industrial setting. Likely, due to those challenges, bacteriophages do not appear to produce consistent, reliable results. [One study](#)²³ found that bacteriophages reduced *Salmonella* spp. by 60–92%—an improvement, but still vastly different from E-Beam’s 99.999+%.

High-Pressure Processing

The most common method, high-pressure processing (HPP), is currently considered the industry standard when it comes to treating raw pet foods. And there’s good reason: HPP can be remarkably effective, destroying a high percentage of harmful bacteria, viruses, parasites, and so on.

However, like the above methods, HPP has significant potential drawbacks. HPP must be applied to food products that contain liquid water. This means that raw pet food that has already been freeze-dried to remove water cannot be HPP-treated. Instead, HPP is performed as an early kill step after ingredients are initially ground, blended, and packed in a disposable plastic casing. Then, after HPP, an extremely high standard of sanitation must be maintained during the rest of processing in order to keep microorganism populations low. This can be a challenge, because these steps include, but are often not limited to, cutting open the disposable processing casing, regrounding the product, and forming the product. These steps provide significant opportunities for microbial recontamination prior to freeze-drying and packaging the final product.

E-Beam

As discussed previously, E-Beam leverages freed electrons to disrupt microbial DNA. E-Beam is a particularly effective kill step because it is done after packaging, so the product is protected from microbial contamination until it is opened by the consumer. The

²³ Soffer, N., Abuladze, T., Woolston, J., Li, M., Hanna, L. F., Heyse, S., Charbonneau, D., & Sulakvelidze, A. (2016). Bacteriophages safely reduce *Salmonella* contamination in pet food and raw pet food ingredients. *Bacteriophage*, 6(3), e1220347. <https://doi.org/10.1080/21597081.2016.1220347>

testing conducted by Carnivore Meat Company and Texas A&M establishes E-Beam as the most effective method for killing pathogens, with the least potential for recontamination and harmful impacts to raw freeze-dried and frozen pet-food products.

Are E-Beam-Treated Foods Still Nutritious?

Although E-Beam is unquestionably effective at deactivating pathogens, some evidence suggests it has the potential to reduce the presence of certain nutrients, such as vitamins A and E.

Pet owners might reasonably question whether E-Beam-treated foods can leave their pets at risk of nutrient deficiencies. To address this concern, Carnivore Meat Company conducted a second study aimed at identifying the effects of E-Beam on the nutrients in raw pet foods.

Study Procedure

1. Sampling: Carnivore began by obtaining samples of the eight raw meat-based pet-food products listed above, specifically pulling from the same production lots used in the Texas A&M study to ensure consistency. Six samples of each food type were collected: three to undergo E-Beam treatment, three to remain untreated.

One of the eight raw meat-based pet-food products, Freeze-Dried Salmon Skins, was omitted due to analytical lab limitations.

2. Treatment: Following their collection, the samples marked for treatment were sent to a third-party E-Beam facility (NextBeam). These samples were dosed with E-Beam at either 9.5 or 12.7 kGy, depending on food type (see Figure 5). Note that both doses are higher than the doses previously established to reduce pathogens effectively.

3. Testing: Next, the samples were shipped to a third-party laboratory (Midwest Labs) for nutrient analysis. The lab performed a wide array of tests on both the treated and untreated samples, looking at all macro- and micronutrients identified by the Association of American Feed Control Officials (AAFCO) as essential for cats and dogs (e.g., protein, fiber, ash, amino acids, fatty acids, minerals, vitamins, etc.). For a full list of tested nutrients, see Addendum.

4. Analysis: The data from the untreated and treated samples were then compared side by side to identify whether nutrient content was statistically different between the two.

Figure 5. E-Beam Treatment Levels for Nutrient-Impact Studies

Products Tested at 9.5 kGy	Products Tested at 12.7 kGy
Freeze-Dried Beef Liver Dices	Frozen Pork Patties
Freeze-Dried Minnows	Freeze-Dried Pork Patties
Freeze-Dried Chicken Hearts	Freeze-Dried Duck Nibs
Freeze-Dried Ground Chicken	

Study Results

Testing yielded three fundamental observations:

- 1. No practical changes were observed in most nutrient categories**, including moisture, protein, fat, amino acids, fatty acids, minerals, and most vitamins.
- Interestingly, **folate was actually detected at higher levels following E-Beam treatment**. The increase in folate is likely attributed to the breakdown of molecular linkages that could have prevented folate from being easily identifiable.
- As expected, **E-Beam treatment reduced detectable vitamin A by 15–30% and vitamin E by up to roughly 50%**. These losses are similar to those recorded in previous studies.

Because E-Beam is known to reduce these vitamins, Vital Essentials intentionally formulates its pet foods to offset such losses, by adding naturally vitamin A-rich raw ingredients such as liver, and supplementing with vitamin E. Vital Essentials ensures that all its pet foods comply with AAFCO requirements, with every product designed to meet the needs of healthy pets.

In contrast, conventional pet foods often over-supplement with a wide array of vitamins, minerals, and amino acids to offset multiple losses in nutrients caused by thermal processing.



Conclusion

Overall, these two studies confirmed E-Beam as a safe and effective way to deactivate harmful microbes without sacrificing food quality or nutrition.

The first study demonstrated E-Beam's ability to achieve high microbial reductions at low to moderate doses, all without introducing radioactivity. The second reaffirmed that E-Beam at these doses reduces the presence of only two essential nutrients, vitamins A and E—an effect easily offset with proper formulation.

Taken together, these studies establish E-Beam as the optimal solution for delivering safer and more nutritious raw pet foods.

Addendum: Tested Nutrients		
Proximate Analysis	Vitamins Cont'd	Fatty Acids
Moisture—As Fed—%	Folic Acid—As Fed—mg/kg	Butyric (C4:0)—As Fed—g/100g
Dry Matter—As Fed—%	Folic Acid—Dry Matter Basis—mg/kg	Caproic (C6:0)—As Fed—g/100g
Protein (crude)—As Fed—%	Cobalamin (B12) as cyanocobalamin—As Fed—mg/kg	Caprylic (C8:0)—As Fed—g/100g
Protein (crude)—Dry Matter Basis—%	Cobalamin (B12) as cyanocobalamin—Dry Matter Basis—mg/kg	Capric (C10:0)—As Fed—g/100g
Fat (acid hydrolysis)—As Fed—%	Vitamin D2 (ergocalciferol)—As Fed—IU/kg	Lauric (C12:0)—As Fed—g/100g
Fat (acid hydrolysis)—Dry Matter Basis—%	Vitamin D2 (ergocalciferol)—Dry Matter Basis—IU/kg	Tridecanoic (C13:0)—As Fed—g/100g
Fiber (crude)—As Fed—%	Vitamin D3 (cholecalciferol)—As Fed—IU/kg	Myristic (C14:0)—As Fed—g/100g
Fiber (crude)—Dry Matter Basis—%	Vitamin D3 (cholecalciferol)—Dry Matter Basis—IU/kg	Myristoleic (C14:1 Trans)—As Fed—g/100g
Ash—As Fed—%	Vitamin E (alpha-tocopherol)—As Fed—IU/kg	Myristoleic (C14:1 Cis)—As Fed—g/100g
Ash—Dry Matter Basis—%	Vitamin E (alpha-tocopherol)—Dry Matter Basis—IU/kg	Pentadecanoic (C15:0)—As Fed—g/100g
Minerals	Vitamin E (beta-tocopherol)—As Fed—IU/kg	Palmitic (C16:0)—As Fed—g/100g
Sulfur (total)—As Fed—%	Vitamin E (beta-tocopherol)—Dry Matter Basis—IU/kg	Palmitoleic (C16:1 Trans)—As Fed—g/100g
Sulfur (total)—Dry Matter Basis—%	Vitamin E (gamma-tocopherol)—As Fed—IU/kg	Palmitoleic (C16:1 Cis)—As Fed—g/100g
Phosphorus (total)—As Fed—%	Vitamin E (gamma-tocopherol)—Dry Matter Basis—IU/kg	Heptadecanoic (C17:0)—As Fed—g/100g
Phosphorus (total)—Dry Matter Basis—%	Vitamin E (delta-tocopherol)—As Fed—IU/kg	10-Heptadecanoic (C17:1)—As Fed—g/100g
Potassium (total)—As Fed—%	Vitamin E (delta-tocopherol)—Dry Matter Basis—IU/kg	Stearic (C18:0)—As Fed—g/100g
Potassium (total)—Dry Matter Basis—%	* Vitamin E (total)—As Fed—IU/kg	Elaidic (C18:1 Trans)—As Fed—g/100g
Magnesium (total)—As Fed—%	* Vitamin E (total)—Dry Matter Basis—IU/kg	Oleic (C18:1 Cis)—As Fed—g/100g
Magnesium (total)—Dry Matter Basis—%	Amino Acids	Linolelaidic (C18:2 Trans)—As Fed—g/100g
Calcium (total)—As Fed—%	Alanine—As Fed—%	Linoleic (C18:2 Cis)—As Fed—g/100g
Calcium (total)—Dry Matter Basis—%	Alanine—Dry Matter Basis—%	Gamma-Linolenic (C18:3 gamma)—As Fed—g/100g
Sodium (total)—As Fed—%	Arginine—As Fed—%	Nonadecanoic (C19:0)—As Fed—g/100g
Sodium (total)—Dry Matter Basis—%	Arginine—Dry Matter Basis—%	Alpha-Linolenic (C18:3 alpha)—As Fed—g/100g
Iron (total)—As Fed—ppm	Aspartic Acid—As Fed—%	Arachidic (C20:0)—As Fed—g/100g
Iron (total)—Dry Matter Basis—ppm	Aspartic Acid—Dry Matter Basis—%	11-Eicosenoic (C20:1)—As Fed—g/100g
Manganese (total)—As Fed—ppm	Cystine—As Fed—%	11-14 Eicosadienoic (C20:2)—As Fed—g/100g
Manganese (total)—Dry Matter Basis—ppm	Cystine—Dry Matter Basis—%	Homo-gamma linolenic (C20:3)—As Fed—g/100g
Copper (total)—As Fed—ppm	Glutamic Acid—As Fed—%	11-14-17 Eicosatrienoic (C20:3)—As Fed—g/100g
Copper (total)—Dry Matter Basis—ppm	Glutamic Acid—Dry Matter Basis—%	Arachidonic (C20:4)—As Fed—g/100g
Zinc (total)—As Fed—ppm	Glycine—As Fed—%	Eicosapentaenoic (C20:5)—As Fed—g/100g
Zinc (total)—Dry Matter Basis—ppm	Glycine—Dry Matter Basis—%	Heneicosanoic (C21:0)—As Fed—g/100g
Chloride—As Fed—%	Histidine—As Fed—%	Behenic (C22:0)—As Fed—g/100g
Chloride—Dry Matter Basis—%	Histidine—Dry Matter Basis—%	Erucic (C22:1)—As Fed—g/100g
Iodine (total)—As Fed—ppm	Isoleucine—As Fed—%	Docosadienoic (C22:2)—As Fed—g/100g
Iodine (total)—Dry Matter Basis—ppm	Isoleucine—Dry Matter Basis—%	Docosapentaenoic (C22:5)—As Fed—g/100g
Selenium (total)—As Fed—ppm	Leucine—As Fed—%	Docosahexaenoic (C22:6)—As Fed—g/100g
Selenium (total)—Dry Matter Basis—ppm	Leucine—Dry Matter Basis—%	Tricosanoic (C23:0)—As Fed—g/100g
Vitamins	Lysine (total)—As Fed—%	Lignoceric (C24:0)—As Fed—g/100g

* Retinol (vitamin A)—As Fed—IU/kg	Lysine (total)—Dry Matter Basis—%	Nervonic (C24:1)—As Fed—g/100g
* Retinol (vitamin A)—Dry Matter Basis—IU/kg	Methionine—As Fed—%	Saturated Fat (total)—As Fed—g/100g
Beta-Carotene (vitamin A)—As Fed—IU/kg	Methionine—Dry Matter Basis—%	Polyunsaturated Fats (total)—As Fed—g/100g
Beta-Carotene (vitamin A)—Dry Matter Basis—IU/kg	Phenylalanine—As Fed—%	Monounsaturated Fats (total)—As Fed—g/100g
Thiamine as Thiamine Hydrochloride—As Fed—mg/kg	Phenylalanine—Dry Matter Basis—%	Trans Fatty Acids (total)—As Fed—g/100g
Thiamine as Thiamine Hydrochloride—Dry Matter Basis—mg/kg	Proline—As Fed—%	Omega-3 Fatty Acids (total)—As Fed—g/100g
Riboflavin (vitamin B2)—As Fed—mg/kg	Proline—Dry Matter Basis—%	Omega-6 Fatty Acids (total)—As Fed—g/100g
Riboflavin (vitamin B2)—Dry Matter Basis—mg/kg	Serine—As Fed—%	Omega-9 Fatty Acids (total)—As Fed—g/100g
Niacin (vitamin B3)—As Fed—mg/kg	Serine—Dry Matter Basis—%	
Niacin (vitamin B3)—Dry Matter Basis—mg/kg	Threonine—As Fed—%	
Choline chloride—As Fed—mg/kg	Threonine—Dry Matter Basis—%	
Choline chloride—Dry Matter Basis—mg/kg	Tyrosine—As Fed—%	
Pantothenic acid—As Fed—mg/kg	Tyrosine—Dry Matter Basis—%	
Pantothenic acid—Dry Matter Basis—mg/kg	Tryptophan—As Fed—%	
Pyridoxine (B6) as pyridoxine HCl—As Fed—mg/kg	Tryptophan—Dry Matter Basis—%	
Pyridoxine (B6) as pyridoxine HCl—Dry Matter Basis—mg/kg	Valine—As Fed—%	
Biotin—As Fed—mg/kg	Valine—Dry Matter Basis—%	
Biotin—Dry Matter Basis—mg/kg	Taurine—As Fed—%	
	Taurine—Dry Matter Basis—%	
* Retinol and vitamin E were impacted (p-value <0.05) by E-Beam irradiation at 9.5 and 12.7 kGy.		