

Exploring the Pros and Cons of Meat-Based and Plant-Based Pet Food Diets

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Abstract

Global issues like population growth, increased protein source rivalry, environmental degradation, and welfare issues for farmed animals are all pushing the development of plant-based pet foods. Their absorption is being hindered, nonetheless, by an absence of proof of adequate nutrition. As a result, some customers might find it more challenging to accept pet meals that are more in line with their morals, and the pet food business might have a harder time completely capitalizing on the capacity of this growing market while simultaneously decreasing its environmental impact. Research on the prevalence of practices employed to guarantee the nutritional soundness (NS) and quality of pet meals, as well as whether plant-based diets (PBD) have minor criteria in these areas, have not yet been conducted. So, to investigate this, we created an investigation. Pet food producers who make 10 vegan, nearly vegan, and vegetarian products and 19 meat-based products were examined. The majority of constructors had suitable or better standards at all phases are evaluated, including the design, construction, transition, and packing stages, with PBD generally outperforming meat-dependents on diets, although there were a few areas where practices could have been improved. To assure customers about the NS of products, businesses, and regulators should apply a variety of best practice processes and a wide range of communication mediums.

Keywords: Pet food (PF), cat food, dog food, vegetarian, vegan, raw meat, plant-based diets (PBD).

Introduction

The demand for pet food is tremendous and rising globally. There are thought to be 3.5 billion dogs and cats around the globe. The market for pet food was worth 131.7 billion euros. The US pet food and treat business was estimated to be worth USD36.9 billion, while it was predicted that the UK pet food market, which had grown 17% over the previous five years, would conclude the year with a value of £2.8 billion. The pet food (PF) industry is not only expanding but also evolving as consumer's significant changes. Numerous investigations have shown that pet owners are becoming more concerned about the nutritional value and quality of PF (1). Ecology, animal welfare, and human health can all be improved by switching from conventional meat to plant-based meat. Conventional plant-based proteins like seitan, tempeh, and tofu, in addition to various vegetarian meat substitutes, have been available in the market for several years. But in recent years, particularly in Western nations, the need for plant-based foods has greatly expanded. Several pet owners constantly fret about potential links among the depletion of animal goods, even for their pets, and issues with animal welfare, the use of herbicides, degenerative health conditions, fertilizers, and climate variation (2). Furthermore, animal tissues are where one can get the majority or only source of taurine, arachidonic acid, eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), and

vitamin A. However, plant-based diets also known as vegan diets are marketed for use in domestic cats and are available in the marketplace. For domestic cats, there are regarded links among health and diet. In addition to needing a diet with balanced nutrition to prevent negative health effects in cats, it is also recognized that several illness states are correlated with nutritional imbalances or the incorrect provision of specific nutrients. The kind of diet a cat consumes can have an impact on their general health, the presence of disease, and even their longevity. It has long been believed that cats, which are obligate carnivores, need a diet rich in foods originating from animals to get the vital nutrients they need. However, the effects of giving cats PB diets have not yet been well explored. Though ten percent of vegan cat owners and almost 1% of all cat owners prefer to feed their cat only PB, this is not a common choice (3).

With trendy diets that may not be in line with animal health, nutritional biochemistry, or physiology, the pet product business and pet food producers have reacted to this cultural change. These diet trends include avoiding grains, cooking at home, and using human-grade products. Among them, the grain-free diet (GFD) movement is probably the most well-known. Pet food manufacturers promote these diets as great-protein ancestral diets which are better than those that also include grains (4). The manufacture of pet food using meat as a main ingredient contributes to the environmental issues related to livestock farming, including deforestation, greenhouse gas emissions, and water pollution. Land, water, and feed are among the several resources needed to grow animals for meat production. Pet food diets made from either meat or plants are meant to give animals the nourishment they need to support their general health and well-being. But the two varieties of diets have different focuses and strategies. Diets for pets that include meat try to replicate the normal diet of omnivorous animals such as dogs and cats (5). The main goal is to provide pets with high-quality animal proteins, vital amino acids, healthy fats, and other nutrients found in abundance in meat. These diets are made to fulfill the particular dietary needs of carnivorous animals and give them the nutrients they need for healthy development, growth, and maintenance of their body functions.

The study (6) utilized pet food and beef chunks as controls to examine how the method meat equivalent reacts to sterilization and storage in media. Before & after sterilization, as well as after storage, the textural characteristics and proximate composition of the chunks were analyzed. After sterilization and packing, the prototype meat analog's fibrous look remained. The study (7) evaluated a pet food and revealed that both cats' average daily consumption of numerous nutrients was below the minimum recommended level. After taking folic acid supplements for dysorexia, both patients' appetites, weights, and mentation returned to normal, and animal-derived foods were later reintroduced into their diets. The study (8) described the increased importance of non-traditional dog diets with alleged health welfare, although taking into account safety issues, new information on the health results of dog consumption K9PBN is pertinent to veterinarians & customers. By comparing the clinical health results of adult dogs given K9PBN throughout 12 months to a meat-based diet in the

beginning, they aimed to determine nutritional equivalency. The study (9) evaluated the environmental effect of a tester on four distinct types of meals: chili, lasagne, curry, and teriyaki, as well as the meat-based, vegetarian, vegan, and whole-food vegan recipe variants. Using life cycle assessment (LCA), 13 meals composed of 33 various ingredients were evaluated for their environmental impacts from production through consumption.

The study (10) examined the body of previous studies on raw feeding and highlights study holes that might be filled by applying sociological methods from the study of human-companion pet relationships. This could contribute to expanding the understanding of raw feeding to include wider social and ethical relationships among dogs and their guardians in addition to health and nutrition. The report begins by referencing previous veterinary research on raw feeding, which exposes gaps in the body of knowledge and underlines issues about nutrition and public health. The study (11) analyzed the justifications, viability, and accessibility of plant-based diets for canines and felines by reviewing the prior research in the field. The research (12) presented an initial analysis of pet food's global environmental effects. The method is new in that it applies an economic worth portion method to the effects of ABPs and other animal products that denotes the conservational load. The study (13) created plant-based mimicked meat; this investigation explores the idea of partially substituting rice bran (RB) with soybean protein isolate (SPI). The study (14) investigated dietary changes among 1942 and 2016 and how a shift to a plant-based diet may affect the P burden entering wastewater therapy executes (WWTW) and subsequent effluent P emission to acceptance of water bodies. The study (15) analyzed the tendency from a commercial standpoint. It detects the weaknesses, strengths, opportunities, and threats (SWOT) for enterprises in the food sector and defines the major worldwide drivers, market trends, market data analysis, and related consumer behavior parts. The study (16) explained the important components used to make these unique products, with a focus on protein sources. As far as they can tell, structural procedures are improved using components that weren't intended for use with meat analogs in the first place. Consequently, it is already standard practice to combine and blend various plant elements to achieve greater usefulness.

Materials and Methods

New Zealand, Asia, Europe, the UK, Australia, North and South America, and Africa all have pet food manufacturing facilities. The PF production association, the trade group denoting the European PF industry, several national PF associations in Europe, the International Feed Industry Federation websites, and the American Feed Industry Association are checked and online searches were conducted to reach this conclusion. To investigate the measures used by pet food producers to assure NS and quality management of their goods, online reviews were created inside JISC online reviews. 88% of UK higher education institutions utilized JISC Online Surveys, which complies with the European General Data Protection Regulation's strict data security criteria. Seven individuals took part and represented small and medium-sized businesses from the majority of continental regions. A dietician from the UK industry was also extensively contacted. The study was subsequently modified, with a certain question

clarified and new ones included, on the respondent's role and pertinent knowledge, the location of the manufacturing facility, the processing of the product, the choices for nutritious and non-nutritive additives, and post-industrialized nutrient losses.

In contrast to vegan diets, which are described as avoiding all animal products, vegetarian diets are those that include plants, milk, and eggs. For ease of use and because of the relatively small sample size, these 2 classes are collectively referred to as PBD ('V') in the results and discussion that follow, even though dry meat-based pet foods do contain a significant amount of plant-sourced ingredients. Common instances consist of soybean meal, corn gluten meal, barley, whole corn, whole wheat, and rice. Though less frequently, wet meals can include proteins from plants. Over 700 pet food vendors who were deemed likely to produce their pet meals or to have an adequate understanding of the production methods utilized for their goods were sent invitations to participate in the final poll via email between May and November 2020. A second invitation was sent to anybody who didn't reply to the first email after at least one month. The random number generator was used to choose 48 companies in November 2020 that were believed to be likely to produce diets without meat. These were invited to join after being reached using personalized phone calls, emails, Facebook messages, or online chats. The measurements made by businesses to guarantee the worth and NS of their PF formulas were then scrutinized and rated as satisfactory, superior, or inferior, at every phase, depending on the highest 52% of the diets within every group achieved most of the criteria, satisfied those criteria suggesting greater ideals, and the existence of additional noticeable variations among dietary groups. This study adhered to the University of Winchester's study ethics policies.

Results and discussion

Participation in the research was proven by 29 respondents. Although North America, Australia/New Zealand/Oceania, and other parts of Europe also played an essential part, businesses were mostly located in the UK and other European countries, with their headquarters and construction services being concentrated in these areas. But the marketing spheres were larger. Several more businesses than there were established in them sought almost all worldwide markets. The UK, other European countries, Asia, North America, and New Zealand were the areas that received the greatest attention in Table (1).

Table (1): Location of the organization's corporate offices, manufacturing facilities, and marketing areas

Company	Africa	Australia/New Zealand/Oceania	Asia	South America	UK	Other European	North America
Production	3	7	5	3	8	14	8
Marketing	4	13	16	9	19	18	12
Headquarters	3	5	2	1	8	9	6

Many pet food manufacturers thought their market share was modest to medium contrasted to other pet food manufacturers marketing in the identical area. Three thought they had a significant market share. Eleven respondents to the study held managerial positions, with the majority working in technical, production, or nutrition jobs. One responder was employed in sales improvement, while the other covered all duties, such as ingredient procurement and marketing. One business claimed to produce a diet that included "other - organic meat." Due to the small number of respondents, it was decided to reclassify this as "meat-based conventional" for the goals of this research because it would not be wise to make a more precise distinction between organic and conventional products.

In general, the diets provided by the investigated enterprises were primarily plant-based (14 total: vegan - 8, vegetarian – 2, almost vegan - 4) or meat-based (26 total: raw – 8, cooked - 18). Insect-based diets were created by two businesses. No businesses reported creating pet foods depending on in vitro meat, fungus, or algae, or diets dependent on any other principal ingredient kinds. Additionally manufactured were snacks (16 firms), supplements (6 companies), and premixes designed to be used with additional items, including a fresh protein source. Supplements included minerals, vitamins, enzymes, amino acids, fatty acids, pro- and pre-biotics, and dual health products. Different moist & dry versions of these diets were offered. The 29 respondents' enterprises provided wet formulas (in the form of raw, canned, pouched, or cartonized food) in 28 cases and dry formulations (in the form of kibble or dehydrated raw food) in 21 cases.

The other portions of the research were devoted to providing data on these aspects and the measures taken to assure product quality control and nutritional soundness. The majority of the outcomes that followed were focused on a particular diet that was the subject of the data that businesses were obligated to furnish. Because there isn't much information available on diets other than "conventional meat-based," corporations were urged to provide an acceptable alternative if they had any, as was previously noted. The diets chosen included 10 plant-based diets (34%) and 19 meat-based diets (66%) 11 conventional diets, such as single organic, 6 raw diets, and 2 with no identifiable meat source. Two responders utilized recipes using other people's designs. All of the 93 percent (27: M - 18, V - 9) of the 29 people who created their formulas claimed to have employed nutritionists, however, the depth of their knowledge varied in Table (2). For 53% of the diets overall, a recognized veterinary specialist in nutrition was utilized. For 34% of diets total, a nutrition expert with various postgraduate nutrition certifications at the master's level or higher was utilized. For fifteen percent of all diets, a nutrition expert without such postgraduate nutrition degrees was also utilized.

Table (2): Greatest degrees of nutritional knowledge were applied while formulating diets, between 27 businesses that created their formulas

Highest level of expertise	V	M	Total
Other specialist in nutrition without the postgraduate nutrition qualifications above	1	23%	16%

Other specialist in nutrition with the postgraduate nutrition qualifications at masters level or higher	34%	34%	34%
Recognised veterinary specialist (i.e. board-certified) in nutrition	68%	45%	53%

These 27 businesses utilized a range of techniques to guarantee that their formulas were nutritionally done as shown in Figure (1), that include feeding tests, the family technique (studies to confirm the product is a member of a product family, of that the lead member has effectively passed a feeding test), and the formulation approach.

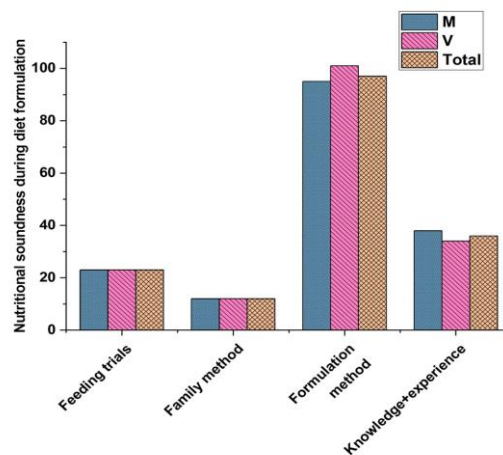


Figure (1): Measures done by businesses to guarantee dietary formulation is nutritionally sound

In 17% of diets, feeding experiments or a related family approach was utilized in tandem. This was 17% for the M and V diets, respectively. In 96% of diets, the formulation approach was used. 37% (10/27) of diets are based on internal knowledge and experience. The nutritional value and high value of the products utilized to construct their diets were also disclosed by all 29 organizations as shown in figure (2).

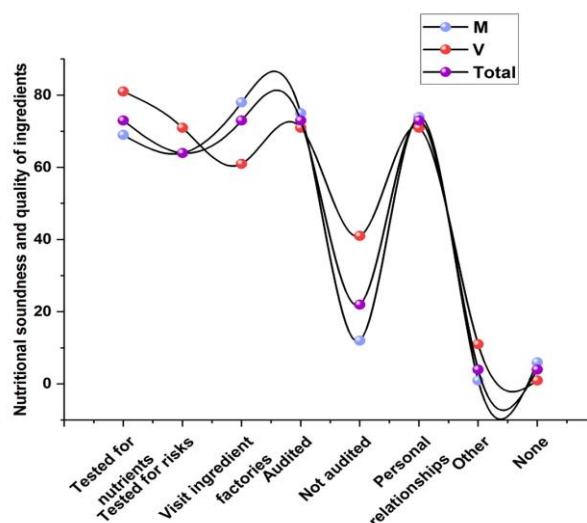


Figure (2): Ensuring that the ingredients are of high quality and are nutritionally sound

The gold normal for guaranteeing the NS and quality of foodstuffs is to assess incoming ingredients for (i) nutrient content and pureness, (ii) for recognized dangers and contaminants. The majority of diets used such evaluations; however, V diets used them slightly more frequently than M diets. Additionally, businesses can go to ingredient manufacturers to inspect them or rely on contracts with them that may or may not be audited. Fewer businesses relied on contractual agreements with 72% of enterprises overall inspecting factories. Strong interpersonal ties with vendors were also frequently depended upon. One business (V) mentioned "independent ingredient certification," and another (M) said it just assumed the soundness of arriving ingredients without taking any extra verification processes.

Twenty-three out of the thirty-nine formulas contained extra nutrients in Figure (3). These percentages were 84% for M diets and 70% for V diets. The main nutrients added as supplements were (i) pro-vitamins, vitamins, or chemically described material having comparable impacts, (ii) trace elements and their compounds, and (iii) amino acids, equivalents, or salts. Overall, 76% received supplemental vitamins, 66% received supplemental trace elements, and 52% received supplemental amino acids. As a result, practically all formulations contained supplements, the most popular of which were vitamins or analogs, followed by trace analogs, amino acids or analogs, and so on. Most formulas included all three as supplements. In the three groups, supplementation is greater for M diets than for V diets.

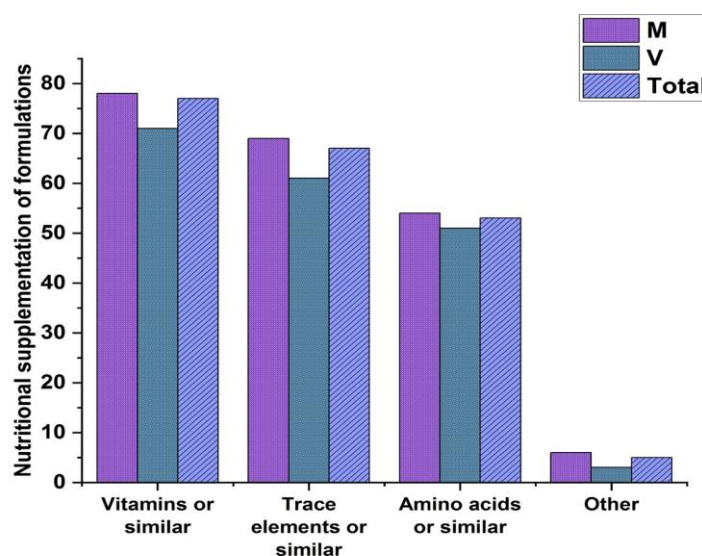


Figure (3): Formulas with additional nutrients

For dry and moist/ raw /semi-moist designs, different physical preservation techniques are used. Twelve of the latter formulations and seventeen of the previous designs (M - 8, V - 9) were examined. Overall, high-temperature sterilization was employed for 88% of the 17 dry formulations (M - 100%, V - 78%). Overall, 59% of the samples were sterilized under high pressure (M - 88%, V - 33%). In total, drying that was effective to prevent the growth of

germs and mould was utilized for fifty-three percent of diets (M - 38%, V - 67%). No formulas used freeze-drying, and all formulas used at least one of these techniques as shown in Table (3).

Table (3): Dry formulas are physically maintained during treatments

Dry formulations	V	M	Total
Drying sufficient to inhibit mould formation and bacterial growth	68%	39%	54%
High temperature sterilization	79%	101%	89%
High pressure sterilization	34%	89%	58%

Only one of the 12 moist/raw /semi-moist designs is made from plants. This design's sole technique of physical preservation was cold sterilization. 45% of the 11 meat-depends on formulas employed steam and great temperature sterilization together and 18% utilized cold sterilization. In 45% of these formulations, no physical preservation technique was used as shown in figure (4).

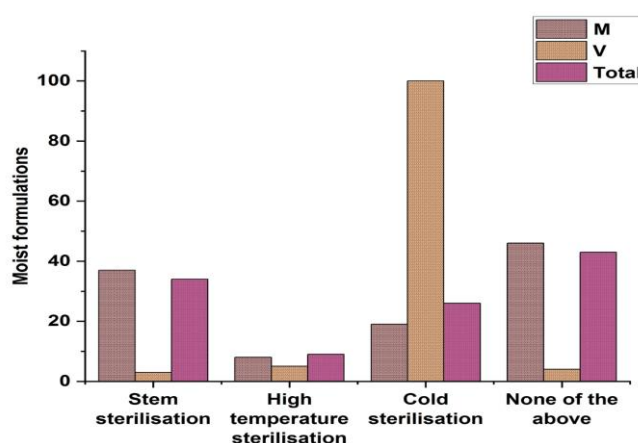


Figure (4): Physical preservation methods for raw or moist compositions.

One or more extra (non-nutritive) additives were utilized in 52 percent of the 29 formulas to: (i) retain nutrients; (ii) improve flavor (iii) prevent bacterial or mold colonization in Table (4).

Table (4): Ingredients added to maintain nutrition, prevent microbial colonization, and maintain or improve flavor or color

Additives: non-nutritive	V	M	Total
Colourants and flavourants	11%	27%	22%
Antimicrobials	11%	17%	15%
Preservatives	61%	43%	49%

Organizations also reported taking a variety of additional steps to maintain the nutrient value and flavor of formulations while they were being manufactured. Three instances of blast

freezing, six instances of other temperature control, and one instance of reducing ambient oxygen were recorded. In total, four out of 29 organizations (14%) claimed they didn't routinely try to forecast the rate of nutrient loss following manufacture. This was 16% for businesses making M formulations, whereas it was 10% for businesses making V formulations. Three of these four organizations gave explanations, citing factors like quick turnaround from production to sale, raw product frozen to -20F until shipped, all shipped within a supreme of 6 months, and confidence in food storage containers with all food shipped before expiration dates. 52% of respondents who were considering post-manufacture nutrient testing went with an outside lab that was accredited by a professional or regulatory authority. In-house nutrient testing was carried out by 28% of the respondents as shown in Table (5).

Table (5): Testing facility for nutrients used after manufacturing

Post-manufacture nutrient testing	V	M	Total
In-house	31%(4)	27%(6)	29%(9)
External laboratory	61%(7)	48%(8)	53%(16)

The two nutrients that these 20 firms examined the most frequently were protein and fat, while ash content and rancidity and pH level or more particular nutrients were examined the least frequently as shown in Figure (5). Amino acids, fatty acids, vitamins, and minerals were present in the latter.

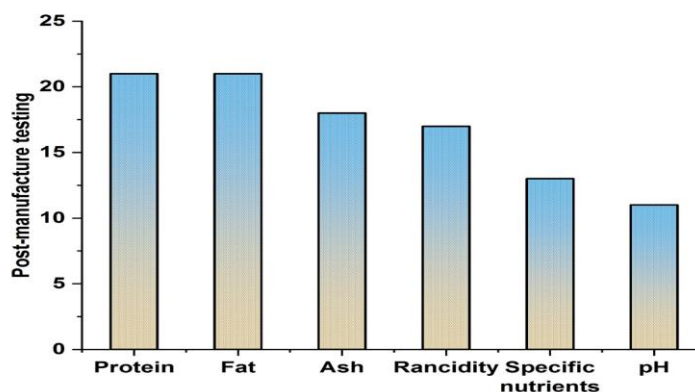


Figure (5): Nutrient content measured during post-production tests

According to 62 percent of the organizations, an excess of nutrients is typically included to accommodate for nutrient loss that occurs after manufacture. 53 percent of M diets and 80% of V diets met this criterion. In addition to particular amino acids, total fat, protein, and fatty acids, they were most frequently stated as vitamins as shown in Figure (6).

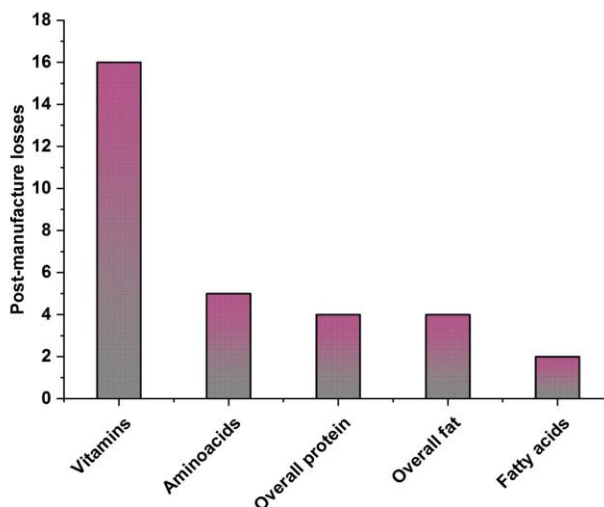


Figure (6): Extra nutrients that structure for post-production losses

Vitamins A, B, D, and E were the most often mentioned vitamins. Some stated that the spectrum was wider, citing, for example, all vital vitamins, especially those proven to be heat labile or degrade over time. Taurine, methionine, and "all" were reported as amino acids, and omega DHA, EPA, arachidonic acid, and linoleic acid were reported as fatty acids. All companies, except one (making an M formulation), reported using standardized practices at various points during the storage and transportation procedure to protect nutritional content or avoid degradation as shown in figure (7).

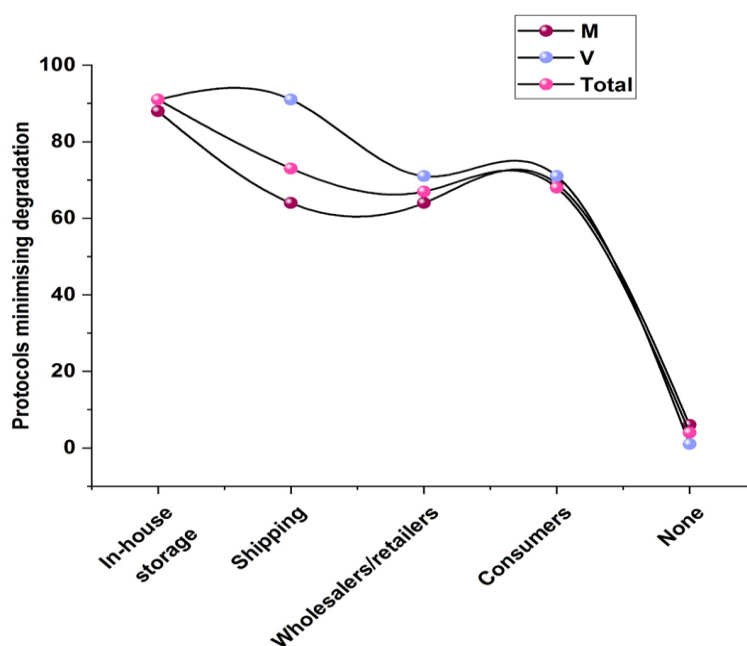


Figure (7): At several points in the supply chain, standardized processes are used to protect nutritional quality or stop degrading

The application of "best before," "use by," and equivalent expiration dates and suggested humidity stages (60%) were the three topics that were most frequently mentioned. The usage or suggestion of specialized handling and storage techniques, such as those related to refrigeration, hygiene, or avoiding exposure to light, has been reported by four organizations. Numerous businesses reported taking extra measures to guarantee nutrient soundness and quality management during the manufacturing phase. In eight cases, the need for laboratory testing to determine nutritional stages was clear. These were performed both internally and by additional laboratories, and ranged from random, per batch, to annual tests. Two instances of testing products or ingredients for germs and one instance of testing for toxins were identified. These included metals and minerals like Mercury, Lead, Arsenic, and Cadmium, pesticides like Dioxin and PCBs, the herbicide Glyphosate, and pesticides like Dioxin & PCBs. Besides conventional advertising, businesses used a range of data channels to teach consumers and merchants about the measures to guarantee the NS and quality management of their products as shown in Figure (8).

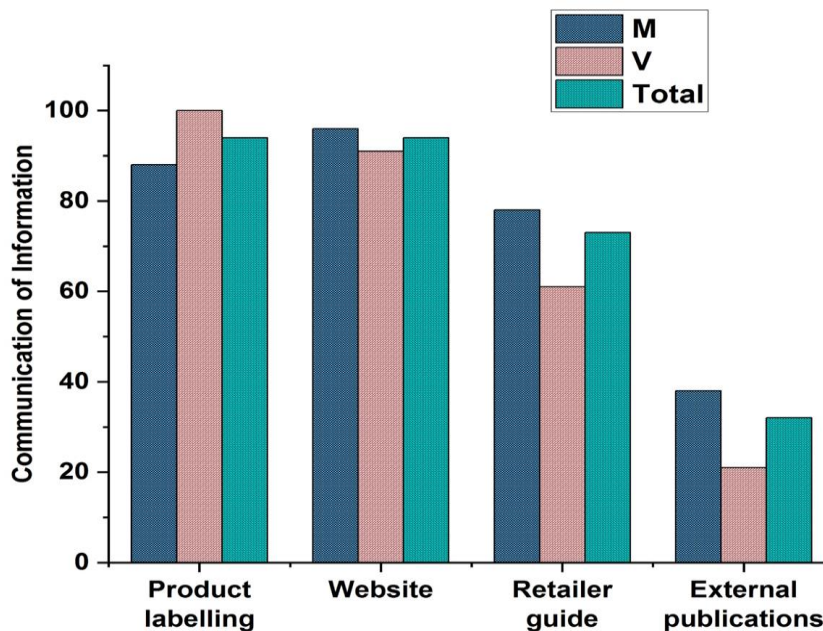


Figure (8): Techniques for informing consumers and retailers about the nutritional value and quality assurance of a product

The two most frequent methods were the use of corporate websites and product labeling to offer data above and beyond what is required by law (93% of the time in each case). M diets were somewhat more likely to utilize websites than V diets were to use product labeling. A product information sheet for retailers was used for this purpose extremely frequently. Therefore, with the exception of external papers, most businesses employed the majority of the modalities that were assessed; however, except for improved product labeling, businesses that produce M formulas appeared to utilize these modalities more frequently. Three businesses also acknowledged utilizing extra communication channels. Additionally, one business reported using YouTube videos, emails, and 24-hour telephone enquiry services.

Discussion

Socioeconomically developed countries had a disproportionate number of the 29 responding corporations. Yet, given that societies with higher disposable incomes have more people owning pets, there are more prospects for the marketing of pet food in those nations. Small businesses made up most of the responding corporations. Such businesses are possible to have fewer improved quality control and NS assurance procedures. As a result, industry-wide practices occasionally may be better than those found in this small research. As an outcome, it's safe to assume that the outcomes are conservative. Most of the respondents held technical, production, or nutrition-related positions, making them the group most likely to be familiar with the measures implemented by their organizations to guarantee NS and worth management. Therefore, it may be believed that this research represents a generally trustworthy reflection of procedures within the investigated organizations. The organizations created a wide variety of wet and dry formulas using raw meat-based, vegan, vegetarian, or almost vegan, and a limited number of insect-depending goods. 19 of the organizations in our study selected to explain one entire diet and 10 of them chose to define a plant-based diet. In vitro, pet diets based on meat, fungi, or algae were not reported to be produced by any organizations, nor were any other sorts of primary components.

Veterinarian nutritionists with board certification offer the best level of nutritional knowledge, monitored by professionals with additional postgraduate nutrition degrees at the master's stage or advanced. Applying the dietary guidelines provided by national/regional organizations is all that is necessary for the formulation technique. It is the bare smallest required to guarantee that preparation is probably full & stable nutritionally, and it is necessary for product licensing and marketing in the majority of jurisdictions. This approach was found to be used by almost all diets. Retailers and customers must be informed of the measures done by businesses to guarantee NS and quality management throughout the manufacturing and supply chain utilizing a variety of interaction modes. These must include data on product labeling that goes beyond the bare minimum required by law, product guides for retailers, and organization websites. The advantages offered by such additions, including preservatives, must be eloquently interacted with consumers to allay their fears regarding 'unnatural' additions. By taking action to ensure businesses present such data more transparently, regulators might offer assistance. Customers should urge businesses to strive for these best practices by inquiring about the measures to guarantee the NS and quality management of their products.

Conclusion

Consumers frequently list the nutritional value of pet foods as one of their main issues, particularly regarding PBD. The worries are reasonably provided the past of product recognition due to contamination, research showing nutritional differences across pet diets usually, and the biological needs of cats which are obligate carnivores by nature. These worries may limit the marketability and acceptance of such diets, particularly among the sizable & rising percentage of customers who already consume PBD. Additionally, this restricts the PBD industry's capacity to employ diets to assist reduce its ecological footprint

and diversify the product line of pet foods. Small businesses made up most of the responding corporations. Larger businesses are expected to require a larger share market and better-enhanced quality control and nutritional assurance procedures. As a result, industry-wide practices occasionally can be better than those found in this small research.

To promote best practices throughout the manufacturing and supply chain, a number of measures might and must be widely applied by businesses and even authorities. Customers may help by asking businesses what actions they have done to assure the nutritional value and worth of the products they sell. Utilizing a wider variety of interaction methods and summarizing the quality control measures taken would comfort customers in general and the sizable minority who are interested in plant-based pet treats in specific. The profits of pets, the market shares of businesses providing great quality diets, and customer issues about the NS of both traditional and plant-based and PBD would all be improved by taking such measures to ensure higher quality diets and better information transparency.

Limitations and future studies

As mentioned, we qualitatively rated companies' efforts to guarantee the caliber and NS of their pet food preparations as substandard, satisfactory, or higher. To better understand the variations among dietary groups, we looked at the percentage of diets that met the different criteria within every group. Although we feel that these data corroborate our judgments, we recognize that other assessors' qualitative evaluations may differ. Yet, following an independent review, there were no conflicts. A statistical evaluation of the observed variations in results depending on diet type M or V would have been nice as well. The two-way chi-square test is the principal statistical technique for examining such disparities. Yet, chi-square tests are invalid when 20% or more of the cells in a table have expected counts of less than 5, as was frequently the case in this research, or when the expected counts of those cells are less than 1. Furthermore, sample sizes of 32 to 785 are needed for even the best tables (one degree of freedom), based on whether the effect sizes are high or small. Hence, the 29-person sample size we used prevented us from performing chi-square significance tests. Since our participant numbers are insufficient to reliably extrapolate the outcomes to all pet food manufacturers generally, even though the outcomes are indicative, we realize that this is the case.

The goal of future studies must be to enlist more participants to enable statistical evaluation of the importance of apparent variations among dietary groups. To get a sample size big enough for statistical evaluation, a lot of effort into recruiting study participants is included. The poll was made to be rather simple to complete, and over 700 companies were twice invited to participate. Additionally, roughly 50 companies received extra, individualized inquiries. The poll was promoted in one industry periodical, and one large industry group politely encouraged its many members to participate, likewise on multiple occasions. The final published report, which was intended to be helpful to everyone, was provided to them all for free. But only 29 out of 688 businesses participated in our survey, or 4%. Online surveys frequently have such low participation percentages. This must be addressed in a future study by setting aside money to pay volunteers for their time. £6,000 would afford

compensation of £30 to 200 people for the expected 15 minutes of work. This would be adequate to identify significant to moderate variations among dietary categories. Smaller disparities would necessitate sample sizes of at least 1,000. *In vitro*; meat is one of the innovative protein sources that is still being developed. Future research with a larger participant pool might also be able to examine a wider variety of food groups.

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