Understanding why managing your vitamin and premix supply delivers consumer assurance

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Ensuring delivery of your pet foods brand promise of quality is vital for consumer assurance. Whilst there are many aspects used to assess quality, the expectation is that the food is safe when consumed and it is what it claims to be on the label. By fully understanding vitamins, vitamin product forms, their application in pet food formulation and vitamin premix quality, manufacturers can take the right steps that will ensure the correct and safe supplementation of their products, which in turn helps to protect brand equity, a company's most valuable asset.

What do vitamins have to do with consumer assurance?

Food quality is high on the consumers' agenda, not only for themselves but also for their animal companions due to highly publicized food fraud scandals, increased nutritional health awareness and pet humanization. DSM's pet owner survey data (2017), demonstrated that owners are concerned about the traceability and origin of ingredients used to make their pets food (Figure1). It therefore makes sense to learn more about your ingredient supply chain to fulfill the consumer need for ingredient sourcing transparency.

As an additional consideration, pet parents now seek foods that reflect current human food, nutrition, and health trends. This has increased the complexity of pet food recipes as novel and humanized ingredients are required to meet the demands of increasingly discerning pet owners. Management of complex ingredient supply chains to source these new ingredients is resource intensive and often difficult to navigate. One ingredient that does however remain constant in pet food recipes is the vitamin premix. It is often overlooked as one simple commodity ingredient. The premix is actually a complex blend of many other ingredients, and should therefore receive individual attention to ensure it is fit for purpose, ensuring safe pet food supplementation (Table 1). Dedicated pet food ingredient and premix manufacturers will help you manage this complexity.

Figure 1:
Pet owner agreement with the statement "I am concerned about the traceability and origin of ingredients used to make my cat's or dog's food"

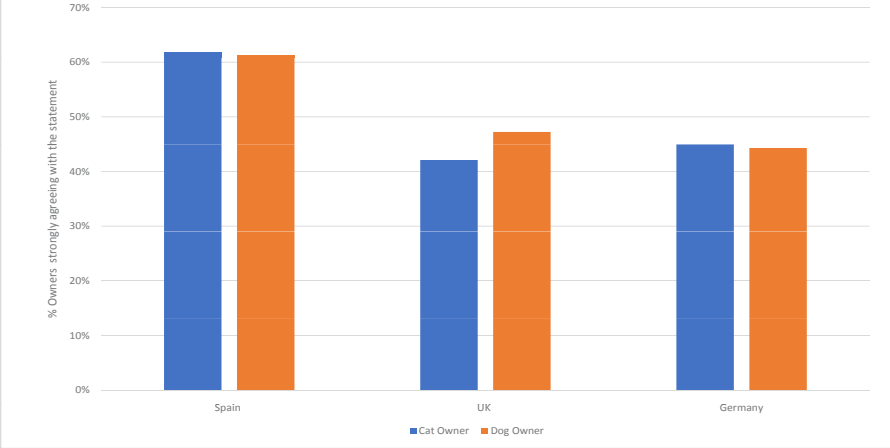

Table 1:
A vitamin premix is one ingredient in a formulation, yet it is easy to forget premixes too are complex recipes, sometimes containing more raw materials than the base pet food

Traditional Recipe Example	On Trend Humanized Style Recipe Example	The Vitamin Premix *
Wheat Corn Meat Meal Soy Protein Wheat Midlings Poultry Fat Flavor Vitamin Premix Blend * Mineral Premix Blend	Fresh Free Range Chicken Sweet Potato Fresh Duck Fresh Salmon Tapioca Lentil Chick Pea Salmon Oil Chicken Fat Dried Carrots Dried Papya Dried Apples Seaweed Dried Algae Prebiotic FOS Glucosamine Vitamin Premix Blend * Mineral Premix Blend	Vitamin A Vitamin D Vitamin E Vitamin K3 Vitamin B1 Vitamin B2 Vitamin B6 Niacin Pantothenic Acid Biotin Folic Acid

Proper dosing of vitamins using a premix is directly linked to pet food safety

Vitamins are only needed in micro amounts by the animal. Individually weighing and adding vitamins

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separately during the food production process carries a high risk. If done incorrectly, nutritional quality or even food safety at the point of consumption will be compromised and can have far reaching consequences (Figure 2). It is therefore essential that they are accurately added to the food. By blending the small amounts of vitamins, or other micronutrients required onto a carrier to create one ingredient, the premix, means they can be safely added to and distributed uniformly throughout the final pet food product. Proactively managing the vitamin sources used in your premix and final premix formulation quality with your supplier is one way to help mitigate the risk of a complex ingredient harming your pet food brand.

High vitamin form quality delivers nutritional safety

For commercially produced pet nutrition products, the vitamins used within them must be safely produced and formulated into specialized forms. These forms must be selected and applied consistently throughout the supply and production chain, from storage and handling to their proper inclusion in a premix, considering the pet food type, production process, and finished food product storage. It is therefore necessary first to understand the importance of vitamin forms, premix formulation considerations, and their application.

Understanding production of the basic vitamins

The basic active vitamins are produced by chemical synthesis, fermentation, extraction (often from a natural source) or by a combination of technologies. During their production there is a possible quality risk based on exposure to chemical solvents, unreacted intermediates and the introduction of other contaminants. The vitamin active producer, such as DSM, will therefore control this risk using proper chemistry, enforcing strict incoming raw material sourcing programs with their suppliers and operate to robust outgoing finished product quality control protocols.

Why do we need formulated vitamins?

In the basic form, various environmental factors affect vitamin active stability to varying degrees (Table 2). Taking their environmental sensitivities into account to improve their intrinsic stability, the basic vitamin actives undergo a process of chemical modification. This includes esterification, phosphorylation or crystallization of the organic salt to create a more stable vitamin compound.

Figure 2: :
Adding the small amount of vitamins required in pet food via a high quality premix ensures accurate vitamin addition distribution throughout the food, ensuring nutritional adequacy and safety for the end user

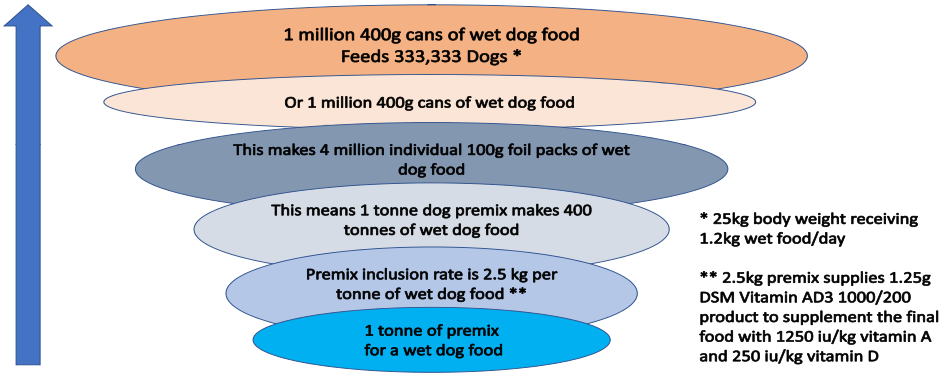


Table 2: :
Many environmental factors can affect stability of the basic vitamin

External Factors Influencing Vitamin Stability

VITAMIN	Temperature	Oxygen	Humidity	Light	pH Acid	pH Alkaline
Vitamin A	✓✓	✓✓	✓	✓✓	✓	●
Vitamin D_3	✓	✓✓	✓	✓	●	✓
Vitamin E-Acetate	●	✓	●	●	●	✓
Vitamin K_3	✓	✓	✓✓	✓	✓✓	✓✓
Vitamin B_1	✓	✓	✓	●	●	✓✓
Vitamin B_2	●	●	✓	✓	●	✓
Vitamin B_6	✓✓	●	✓	●	●	●
Vitamin B_{12}	✓✓	✓	✓	✓	●	●
Pantothenic Acid	✓	●	✓	●	✓	✓
Nicotinic Acid	●	●	●	●	●	●
Biotin	✓	●	●	●	●	●
Folic Acid	✓✓	●	✓	✓✓	✓✓	●
Vitamin C	✓✓	✓✓	✓✓	✓	●	✓

●=Stable ✓=Slightly Sensitive to Sensitive ✓✓=Very Sensitive

The importance of working with the appropriate vitamin formulation

The vitamin compounds are finally formulated into specific vitamin forms to make them suitable for use in a variety of pet food, treat, drink, and supplement products. The formulation process ensures basic vitamin stability "as-is" during storage, when used during processing and storage of the final product, whilst remaining bioavailable to the user animal. In addition, vitamin forms are optimized to ensure regulatory compliance, good handling properties and optimal mixability in premixes and dispersion in the food. Many forms of vitamins are produced ensuring many pet nutrition products can be supplemented with vitamins, for example DSM produces a special water-soluble form of the fat-soluble vitamin A (Table 3).

Many form technologies can be used to stabilize the vitamin compound by controlling oxidation, minimizing contact with hostile compounds, or shielding them from high heat processing. Cross-linked beadlet technology for example, is used to create another stabilized vitamin A form, this time insoluble, for in food use (Figure 3). During this process the vitamin A compound, vitamin A acetate, is emulsified in a gelatin (protein), starch and glycerin matrix, with an antioxidant. During the formation of the beadlet, chemical reactions occur that create crosslinked bonds between the amino acid chains thereby creating a rigid structure. This technology provides excellent stability and is used to protect nutrients sensitive to high temperature processing and oxygen. The protein based vitamin coating is easily digested, ensuring the vitamin remains bioavailable to the animal upon consumption.

Table 3: :
The vitamin form chosen to supplement the pet nutrition product will depend on how that product is processed and its physical characteristics

Product Form Requirements

	Heat Stable	Moisture Stable	Shear Tolerant	Resistant to Oxidation	Not Adversely Affected by Enzyme Activity	Low Coloration and/or Small Particle Size	Compression Tolerant	Resistant to UV Light	Proper Solubility or Miscibility
Extrusion	●	●	●	●					
Baking	●	●	●	●	●				
Restoring/Steaming	●	●	●	●	●	●			
Fresh/Frozen		●	●	●	●				
Injection Molding	●	●	●	●	●				
Dry Mixing/Powder	●		●	●		●			
Tableting/ Compression	●		●	●		●	●		
High Fat Liquid	●	●	●	●	●	●		●	●
Low Fat Liquid/Milk	●	●	●	●	●	●		●	●
Clear Water	●	●	●	●		●		●	●

Vitamin form potency is also considered during its development. This is important, especially when very small amounts are required to be homogeneously distributed throughout the food. A spray dried biotin form, for example results in more homogeneous distribution of the active biotin particles than if an unformulated, triturate biotin source is used (Figure 4). Homogeneity of vitamin distribution is linked to safety of the pet food, as each bite must not over- or under-deliver any vitamin, which may result in toxicity or deficiencies respectively.

Vitamin forms are also produced in a way to manage their electrostaticity, dustiness and hydroscopicity. These can all differ between manufacturers. Particles that are highly electrostatic can migrate towards attractive surfaces or separate from the premix during transport reducing levels in the food. Dusty product forms may pose a health risk to handlers and can also be lost, consequently reducing the amount added to the food. Poor product forms with hydroscopic tendencies cause lumping, poor premix flowability and issues with the entire premix stability.

It is now easy to conceive that sourcing your vitamins from an experienced vitamin producer helps maintain the necessary consistency to ultimately produce a best quality vitamin premix for your pet foods.

Developing a quality premix: how does your vitamin premix affect the quality of pet foods

Many factors need to be considered when designing a vitamin premix specification and selecting vitamin forms to deliver the desired nutrient levels in the pet food at the point of consumption. These include the species to be fed, label or functionality claims that must be fulfilled and the type of product requiring fortification. Expected vitamin loss during production and storage should also be reflected in the specification, with vitamin activity overages calculated accordingly.

Importance of the vitamin premix carrier

The correct premix dilution rate with a suitable carrier is required to ensure premix flowability, ease of handling and final weighment at the food production plant. The carrier also supports proper distribution of the vitamin forms within the food mix. The quality of carrier used as the premix base is just as important as the vitamin forms used. Carriers help bridge the often-unavoidable differences in micro-ingredient product form size, shape and density. Organic carriers such as rice hulls, pea fiber, corn and wheat middlings provide a large surface area or pockets for the nutrient ingredient forms to adhere to, whilst calcium carbonate increases bulk density of the premix and improves flowability. A combination of inorganic and organic carriers is often used to help improve the homogeneity of micro-ingredient distribution within the premix. Carrier ratios can be modified to manipulate premix bulk density to specific handling needs if necessary. Another important consideration to discuss with your premix supplier is the final pet foods' marketing claims, for example grain free. This means the premix carrier should also be grain free.

Premixes are a critical link in the pet food supply chain and allow accurate, safe, and homogeneous micronutrient and functional ingredient inclusion into pet food products. By working together with your vitamin producer and premix supplier a successful and safe pet food product can be achieved.

The importance of quality programs and culture

Pet food manufacturers can help manage their vitamin supply quality by selecting vitamin producers and blenders that are reputable, can demonstrate that they have an employee culture living quality and safety consciously and also have brand equity to protect. Food safety is key. A quality and safety program designed around food safety standards, integrating all business processes, managed by a team of qualified quality

Figure 3: :
Micrograph and cross-section of Vitamin A 1000 beadlets

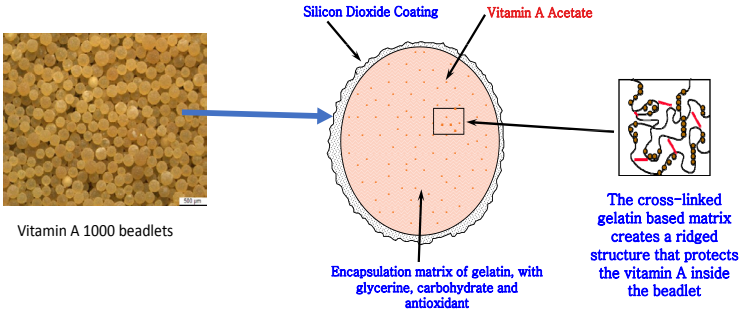
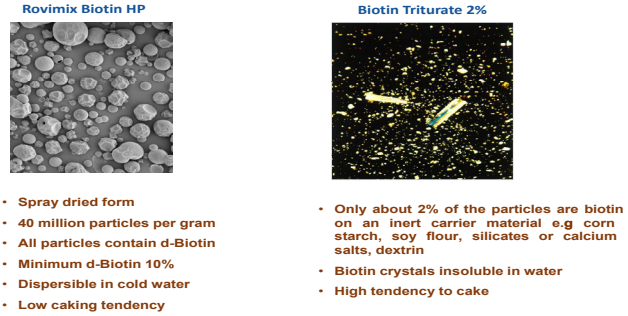


Figure 4: :
Spray dried biotin form vs biotin triturate



and safety managers is essential (Figure 5).

Figure 5: :
A quality program, designed around food safety must integrate the whole business, its processes and people

Central to quality and safety programs is the correct implementation of Hazard Analysis of Critical Control Points (HACCP). This works within World Health Organization standards and comprises sanitation standards, pest control systems, and minimizing cross-contamination during production. A sharing and learning culture ensures that all within a company become integrated into the company's quality and safety program. Through a living consciousness of quality and safety across all employees, it becomes part of your company's culture, and empowers all to fulfill promised food safety and quality behavior and embrace well-designed Standard Operating Procedures. Working with companies that invest in their employees' ongoing development and quality training is one way to ensure this is the case. On a global scale, DSM uses Compliance Quality Management (CQM) TrackWise® system and other companywide web-based training tools, to ensure every DSM employee becomes integrated into our global quality culture and safety program.

An important part of quality control is change management. Change management systems must be in place and be robust. A supplier's mindful knowledge of the risks to their customers and the sustainability of their businesses is essential. Leading ingredient suppliers will be perpetually working to improve their food safety program. This is part of DSM's business strategy we call this "closing the loop". Through this system, root cause analysis on deviations can be carried out and, management of change tools implemented which covers not only the practical issues, but most importantly how best to manage the people side of change.

Integrated supply chain and traceability

Pet retail products range from concentrated dietary supplements to pet foods designed to deliver 100% of the animal's daily nutritional needs. Due to this complexity, and the safety concerns associated with these types of retail products, it makes sense that ingredient traceability is vital. A trusted supply chain is therefore needed. A food safety program in line with food safety standards is the basis for this, starting with strict ingredient vendor qualification and management processes. Robust and integrated documentation, goods receipt, and warehouse management systems are required, which should be open to interrogation.

The process of manufacturing bioactive micro-nutrients, and blends of micro ingredients, is complex from a quality assurance perspective. Through involvement in all three steps of the nutritional ingredient chain – the production of pure active ingredients, their incorporation into sophisticated forms, and the provision of tailored premixes – integrated premix and micro-ingredient producers, such as DSM, offer unrivaled traceability to the pet food industry. Traceability, supported by rapid global track & trace systems provides an additional assurance of safety.

Being a dedicated supplier to the pet food industry

Suppliers that understand the needs of pet food brand owners will not only have a robust market-specific continual improvement program in place, but will also continue to invest in providing additional solutions to manage risk and create points of differentiation for pet brands. They do this by having dedicated pet food and regulatory specialists that live the needs of the pet food manufacturing industry. As an outcropping of this dedication at DSM, a pioneer in vitamin and vitamin form production, innovative ingredients have been developed to solve issues associated with pet food production vitamin stability, or to provide functional health benefits for pets. Our vitamin C form, STAY-C® 35 was the first stabilized vitamin C form available to the pet food market. Following this, by harnessing our expertise in both human and animal nutrition, further developments in vitamin form production led to the production of STAY-C® 50, a specialist soluble vitamin C form that can be used in pet foods to support dental health. Our ROVIMIX® Beta-Carotene 10% P, was specially developed for the pet food market and is the only extrusion and storage stable beta-carotene form available to the market today.

Trusted partner

Understanding the complexity of essential ingredients like vitamins, and vitamin premixes, underscores the importance of understanding what contributes to your product's quality, nutritional safety and ultimately supplier selection. We also recognize that beyond the growing concerns surrounding managing your products quality and safety, it is an increasingly more difficult task for brand managers to create points of differentiation based on nutritional claims, considering regulatory and economic constraints. Leveraging our own broad portfolio of health ingredients, working with other leading ingredient manufacturers, applying years of pet nutrition knowledge and experience, combined with our own market research of pet consumer perceptions, allows DSM to be a partner that helps strengthen the quality of your supply chain whilst providing quality solutions for your brand.

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