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Stabilizing Rendered Ingredients, Animal Feed and Pet Food

Recent FDA enforcement of rules regarding the use of ethoxyquin creates new challenges

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As North America's leading producer of animal fats and proteins, representatives from Darling International and Griffin Industries (the two rendering companies merged in December 2010) are often asked to clarify the FDA's position regarding the use of ethoxyquin and other stabilizers. The below paper highlights these frequently asked questions. Furthermore, in October 2012, Darling and Griffin unified their go-to-market strategy in the promotion of our related animal fats and proteins under DAR PRO Solutions, A Darling/Griffin Brand. Throughout the paper, the DAR PRO Solutions brand name will be used when referring to Darling International and/or Griffin Industries' efforts in this regard.

1. Why add stabilizers to feed ingredients, animal feed and pet food?

Lipid (fat) quality is prone to deterioration by oxidation. The process of deterioration (fat oxidation) is a complex process that is thought to occur in phases: (1) initiation, (2) auto-oxidation, and (3) termination. During each phase, the formation of products increase and decrease over time. Hydroperoxides form when oxygen and unsaturated fatty acids combine in the presence of a catalyst (such as iron, copper, heat, UV-light, enzymes, etc.) during the initiation phase. These peroxides (tasteless and odorless) are reactive and can combine with other fats to form additional reactive products during auto-oxidation. Shorter chain aldehydes and ketones are formed during the termination or final phase. These compounds are volatile and responsible for the odors associated with rancidity.

Factors that accelerate oxidation include elevated temperatures, the presence of cationic metals such as iron and copper, the presence of oxygen, and the degree to which a fat is composed of unsaturated fatty acids. Synthetic and natural sources of stabilizer compounds can be added to prevent or block the oxidation process and/or remove cationic mineral catalysts from the reactions (chelates). A few of the antioxidant sources include ethoxyquin, BHA, BHT, TBHQ, propyl gallate and mixed tocopherols. Citric acid is commonly used as a chelator.

Some studies have shown negative effects of oxidized fats on poultry and swine productivity when diets contained at least 4.0 meq/kg of lipid peroxides (Cabel et al., 1988; Dibner et al., 1996; Derouchey et al., 2004; Fernández-Dueñas 2009; Harrell et al., 2010). Conversely, in other studies where lipid peroxides in the diets were present at lower than 4 meq/kg, no impacts on poultry or swine performance were shown (L'Estrange et al., 1966; Lea et al., 1966; Kirkland & Fuller 1971; Cabel et al., 1988; Leeson et al., 1997; Pesti et al., 2002; Fernández-Dueñas et al., 2008).

Consequently, efforts to monitor and control fat oxidation in poultry and swine diets have been primarily driven by the balance of two factors:

1. The likelihood of oxidation exceeding such limits in unstabilized diets which are quickly manufactured and consumed, versus
2. The cost of further controlling oxidation with the use of stabilizers.

Unlike poultry and swine diets, pet foods and pet food ingredients can have extensive time "on the shelf" where uncontrolled fat oxidation can lead to negative effects on food flavor, aroma, texture, vitamin levels, essential fatty acids content, and lead to the production of harmful compounds. For dogs, a moderate level of oxidation decreased palatability of the diet (Gross et al., 1994); and in puppies, decreased growth (Turek et al., 2003). Increased levels of fat oxidation in puppy diets have corresponded to reduced levels of circulating Vitamin E and linoleic acid as well as lower bone deposition of linoleic acid. These puppies also showed elevated platelet counts and lower measures of certain immune system functions (Turek et al., 2003).

The use of synthetic antioxidants has fallen out of favor with consumers. Thus the newer challenge in stabilizing pet foods and pet food ingredients is to delay the onset of oxidation through the use of "natural" stabilizers such as mixed tocopherols, spices, chelators and emulsifiers early in the process. Renewed emphasis has also been placed on good manufacturing practices and managing logistics to create quicker product turnover.

2. Why is ethoxyquin used in animal feeds and some pet foods?

Ethoxyquin has been used in certain animal feeds for at least 50 years to control the generation of lipid oxidation compounds (Dzanis, 1991). In addition, ethoxyquin has been shown to mitigate the effect of oxidized fats in animal diets. By adding 125 ppm ethoxyquin to broiler diets which contained 175 meq/kg of lipid peroxides, the negative effect of oxidized fats on growth was ameliorated (Cabel et al., 1988). (Table 1)

Table 1. Effects of PV on Final Weight (kg) of Broilers Fed Poultry Fat With or Without Ethoxyquin for 49 Days.[1]

Ethoxyquin added	Peroxide level (PV, meq/kg)				Average ethoxyquin
	0	50	100	175	
0 ppm	1.63 [bc]	1.63 [bc]	1.61 [c]	1.53 [d]	1.6
62.5 ppm	1.64 [bc]	1.64 [bc]	1.64 [b]	1.56 [cd]	1.62
125 ppm	1.65 [bc]	1.64 [bc]	1.60 [c]	1.61 [bc]	1.63

[1] Cabel et al., (1988), 5% poultry fat added to corn-soybean meal diets.

[bcd] Treatment means without a common superscript differ (P< .005).

3. Why are there issues with using ethoxyquin in animal proteins, fats and other pet food/feed ingredients?

The Food Additive Listing 21 CFR 573.380 governs the use of ethoxyquin in animal feeds and pet foods. It states ethoxyquin can be safely used as: (1) a chemical preservative for retarding oxidation of carotene, xanthophylls, and vitamins A and E in animal feed and fish food; and (2) as an aid in preventing the development of organic peroxides in canned pet food. In addition, the maximum quantity of ethoxyquin permitted to be used and to remain in or on the treated article shall not exceed 150 parts per million (ppm). In July 1997, the FDA's Center for Veterinary Medicine requested the level of ethoxyquin in dog food be voluntarily lowered to 75 ppm to ensure an adequate margin of safety for lactating female dogs and possibly puppies.

For decades, the rendering and feed industries have interpreted the rule to permit the use of ethoxyquin to control the development of peroxides in complete pet foods and animal feeds. Furthermore, since rendered products such as poultry meal, meat and bone meal, and animal fats are not complete feeds, but rather ingredients that represent only portions of complete diets, use of ethoxyquin at higher efficacious levels was considered acceptable as long as the amount of ethoxyquin these ingredients contributed did not exceed the regulated or voluntary limit in complete diets. The Food and Drug Administration (FDA) had not challenged this interpretation for at least forty years. Recently, the FDA reversed their stance and began issuing notices of violation to renderers using ethoxyquin to stabilize their finished ingredients.

4. Is anything being done to retain ethoxyquin as a stabilizer?

Novus International is working towards filing a Feed Additive Petition (FAP) with the FDA in which they will request broader use provisions to include prevention of fat oxidation in animal feed. In addition, they are requesting a redefinition of the 150 ppm limit to mean the residual concentration of ethoxyquin present in the treated material. The National Renderers Association is coordinating renderers' support of Novus's efforts. While the FDA considers the merits of the FAP, there is hope that the use of ethoxyquin in animal feed and pet foods at 150 and 75 ppm, respectively, can continue.

5. Are there alternatives to ethoxyquin?

Synthetic antioxidants such as BHA, BHT and TBHQ have been used successfully for years in human, animal and pet foods. The use of these alternatives is regulated by the FDA in animal feeds and pet foods as chemical preservatives in 21 CFR 582 subpart D and 21 CFR 172.185. They can be used singularly or in combination with each other not to exceed 0.02% of the oil or fat content of the food. According to DAR PRO Solutuions' testing, these alternatives show promise in replacing ethoxyquin in some targeted situations. Nevertheless, there are other situations where these alternatives do not perform as well as ethoxyquin to protect feed/food ingredients. Consequently, DAR PRO Solutions is currently collaborating with antioxidant suppliers to develop cost-effective alternatives.

Natural alternatives currently available require higher application rates to be effective. In most cases, these alternatives are quite expensive and do not provide the same residual protection as the synthetic alternatives.

6. What resources does the rendering industry have to evaluate/develop stabilizers as alternatives to ethoxyquin?

Understanding fat oxidation, evaluating best methods for measuring relevant effects, and developing novel approaches to mitigation are high priorities for the rendering industry. The rendering industry, composed of independent renderers like Darling International and Griffin Industries, direct research dollars through the Fats and Proteins Research Foundation (FPRF) to investigate and solve such common challenges and issues. In an immediate response to the ethoxyquin challenge in October 2012, FPRF approved a research initiative proposed by Dr. Greg Aldrich, Coordinator of the Pet Food Program at Kansas State University. This work will evaluate techniques for extending shelf-life of rendered protein meals.

The rendering industry also funds work through a partnership with Clemson University. The Animal Co-Products Research and Education Center (ACREC) was formed seven years ago with the mission of addressing such emerging challenges as well as operational and biosecurity issues for the rendering industry. Although the partnership is relatively new, two projects have focused on developing natural peptides as potentially new commercial sources of antioxidants. One of those is in the scale-up pilot stage.

7. What is DAR PRO Solutions doing?

DAR PRO Solutions is collaborating with its antioxidant suppliers to monitor efficacy of current replacement antioxidant ingredients, adjustments to their inclusion levels, as well as to evaluate the potential of new formulations. This will be an on-going initiative and influenced by the outcome of FDA's response to the Food Additive Petition. Rest assured that DAR PRO Solutions will work diligently to find the optimum, cost effective solution.

8. How will DAR PRO Solutions evaluate the oxidative stability of its products?

DAR PRO Solutions operates two centralized labs; one located in Ankeny, IA and the other in Butler, KY. Both routinely monitor peroxide values (PV) in finished products. The Butler lab also monitors the shelf-life of products by means of the Oxygen Stability Index test (OSI). Outcomes from the OSI test indicate how well a product has been stabilized and resist oxidation over time. Selection of the most cost-effective antioxidant(s) and their inclusion levels will be based upon these results. DAR PRO Solutions also uses third-party laboratories to monitor residual antioxidant levels in our finished products. This helps complete our understanding of how well our stabilizing strategy is protecting the quality of DAR PRO Solutions' products and what changes, if any, are needed to optimize that quality.

In conclusion, Darling International and Griffin Industries, under our DAR PRO Solutions' brand, is committed to continuing to ensure our customers feed ingredients meet the highest quality and safety standards in the industry. Furthermore, we will continue to work with the FDA to identify stabilizer solutions that meet current and future directives and perform for our animal and pet food manufacturing customers.

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