

3 Ethoxyquin

BY MT ARNAIZ

Ethoxyquin is a quinoline-based antioxidant used for the preservation of food and feeds. It is also a pesticide (under commercial names such as “Stop-Scald”) used to control scald on pears after harvest. Ethoxyquin is also commonly used in spices to prevent color loss due to oxidation of the natural carotenoid pigments.

Ethoxyquin, 6-ethoxy-1, 2-dihydro-2, 2, 4-trimethylquinoline, has a molecular formula $C_{14}H_{19}NO$, formula weight 217.31 and chemical structure as shown in Figure 3.1. It is a clear light yellow to dark brown viscous liquid (Figure 3.2), has a Mercaptan-like odor, discolors and stains badly. Ethoxyquin is stable, combustible and incompatible with oxidizing agents and strong acids. On exposure to light and air, it polymerizes and darkens in color. It is soluble in organic solvent (50 mL/L in ethanol) and has very low solubility in water (<0.1 g/100 mL at 20°C) (CAS Database reference).

In feeds and feedstuffs, oxidation occurs resulting in rancidity of fats, destruction of Vitamins A, D, and E, pigments (carotenoids) and amino acids which results to lowered biological energy values for the diet. Qualifications for an antioxidant to be useful in animal feeding include (a) must be effective in preserving animal and vegetable fats, vitamins, and other feed qualities subject to oxidative destruction; (b) it must be non-toxic to man and to farm animals (i.e. chicken, swine, fish, etc); (c) should be effective at very low concentration; and (d) low cost to be economically practical. The commonly used feed antioxidants for feeds and feed ingredients which were found to be outstandingly efficient and economical are ethoxyquin (EQ), butylated hydroxytoluene (BHT), and butylated hydroxyanisole (BHA). Among the three, EQ has demonstrated to be the most effective, followed closely by BHT and BHA (Rumsey, G.L).

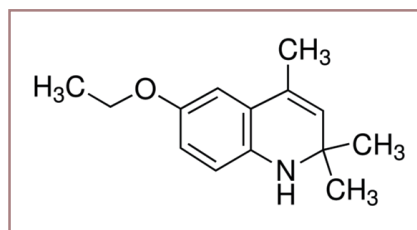


Figure 3.1. Structural formula of ethoxyquin Figure 3.2. Ethoxyquin

Photos courtesy of <http://www.mpbio.com/product.php?pid=02157963> (Figure 3.1) & <http://www.asia.ru/en/ProductInfo/440832.html> (Figure 3.2)

Table 3.1. Tolerances of ethoxyquin

Product	Tolerance level (parts per million)
Uncooked fat of meat from animals except poultry	5
Uncooked liver and fat of poultry	3
Uncooked muscle meat of animals	0.5
Poultry eggs	0.5
Milk	0.0

Ethoxyquin has been known to be one of the best feed antioxidants, however, a review of its use as animal feed (Błaszczuk, 2013) cited that it is responsible for a wide range of health-related problems in dogs, as well as in humans. Ethoxyquin may also show prooxidant properties when too high concentration is used. Dogs are more susceptible to its harmful effects, the symptoms observed were liver, kidney, thyroid and reproductive dysfunction, teratogenic and carcinogenic effects, allergic reactions, and a host of skin and hair abnormalities. The same characteristic symptoms and pathologies, such as weight loss, liver and kidney damage, and alterations of alimentary duct were observed in different species of the majority of animals treated with ethoxyquin at concentrations higher than those permitted in animal feed. Further in Błaszczuk's review article, there were some studies showing cytotoxic effects of ethoxyquin (purity>97%). It induces apoptosis (programmed cell death) in *in vitro* cultured human lymphocytes, the number being dependent on the treatment time. It caused

also DNA damage in the comet assay, however, most lesions could be repaired by cellular DNA repair systems. By using chromosome aberration test, the unrepaired DNA damage induced by ethoxyquin could lead to permanent changes in genetic material. These anti-oxidant induced chromosomes aberrations in human lymphocytes and Chinese hamster ovary cells, are known to have serious biological consequences.

Ethoxyquin may be safely used as an antioxidant for preservation of color in the production of chili powder, paprika, and ground chili at levels not in excess of 100 parts per million (US FDA 21CFR172.140). It may be safely used in animal feeds, provided the maximum quantity of the additive permitted to be used and to remain in or on the treated article shall not exceed 150 parts per million (US FDA 21CFR 573.380), and should be intended for use only as:

- 1) 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. Further, established tolerances for residues of ethoxyquin in or on edible products of animals is shown in Table 3.1.

In 2012, Japan lowered the the residual limit of ethoxyquin in shrimp to 0.01 ppm. Consignments containing more than this

References

Alina Błaszczyk, Aleksandra Augustyniak, and Janusz Skolimowski, Ethoxyquin: An antioxidant Used in animal Feed, International Journal of Food Science, Volume 2013 (2013), Article ID 585931, 12 pages (<http://dx.doi.org/10.1155/2013/585931>)

Japan Food Chemical Research Foundation, accessed thru http://www.m5.ws001.squarestart.ne.jp/foundation/agrdtl.php?a_inq=10700, August 16, 2014

Rumsey, G. L. Aquaculture Development and Cooperation Programme. Fish Feed Technology. Ch. 10. Antioxidants in Compounded Feeds. FAO Corporate Document Depository

allowable limit were rejected. This beleaguered the countries which considers Japan as one of their top export market. Shrimp exports from Vietnam experienced 100% inspection in that year. India's shrimp export to Japan also suffered from this move of the Japanese government. In the Philippines, shrimp/prawn growers were also alarmed, especially those from the province of Negros Occidental in Western Visayas region, one of the top shrimp/prawn growers in the country. Among the efforts put forth to alleviate the situation, in addition to their agreements and requirements with feed suppliers, is strengthening their capacity in the analysis of ethoxyquin in feeds and in produce. However, in January 2014, Japan formally announced that they increased the allowable limit from 0.01 ppm to 0.2 ppm (<http://vietfish.org/20140219032211848p49c82/japan-raises-maximum-residue-level-for-ethoxyquin.htm>), a twenty-fold increase, but still lower than that of the US FDA's limit of 0.5 ppm for uncooked muscle meat of animals. This move however, may have brought some relief to exporting countries like Vietnam, India, and the Philippines. Among the food products listed that have established maximum residue level (MRL) of ethoxyquin in Japan, crustaceans ranked second to chicken and other poultry muscle, which have 0.1 ppm, while in fish, MRL is 1 ppm (Japan Food Chemical Research Foundation). Studies on the withdrawal period of ethoxyquin from the muscles of fish and shrimps are very limited, if there is any.

US Food and Drug Administration 21CFR 573.380

US Food and Drug Administration 21CFR172.140

Vietnam Seafood Trade. <http://vietfish.org/20140219032211848p49c82/japan-raises-maximum-residue-level-for-ethoxyquin.htm>

Wikipedia. <http://en.wikipedia.org/wiki/Ethoxyquin>