

Volume of Antibiotics Sold (2001 and 2002) in US Domestic Aquaculture Industry

¹John R. MacMillan, ²Roz Schnick, and ³Gary Fornshell

¹National Aquaculture Association, 111 W. Washington Street, Ste. 1, Charles Town, WV 25414-1529

²Michigan State University, LaCrosse, WI 54603

³University of Idaho Cooperative Extension System
246 3rd Avenue East
Twin Falls, ID 83301

Abstract

The public health significance and environmental impact of antibiotic use by the US domestic aquaculture industry is unknown. Several factors must be examined to make such determinations including, but not limited to, the volume of antibiotics used, the fate of antibiotics used, the relative impact and ecological significance of antibiotics on microbial flora in specific environments, and the probability that use of antibiotics under aquaculture processes leads to development of human pathogens resistant to that antibiotic. Scientifically credible data has been scarce leading to considerable speculation. This report provides information as to the actual volume of antibiotics active ingredient (A.I.) sold to the domestic aquaculture feed industry in 2001 and 2002. It is assumed that the volume sold is equivalent to the volume used that year in the domestic aquaculture industry. Only two antibiotics are approved for use by the FDA Center for Veterinary Medicine (CVM) and available in the domestic aquaculture industry. These are approved only for therapeutic purposes for catfish, salmonids, and lobster (oxytetracycline) or for catfish and salmonids (ormetoprim: sulfadimethoxine). In the 25 month period from Jan. 2001 to Feb. 2003, there was 36,126 kg of ormetoprim: sulfadimethoxine A.I. sold. Averaged out, the amount sold per year was 17,340.48 kg of ormetoprim:sulfadimethoxine A.I. In 2001 there was 15,200 kg A.I. of oxytetracycline sold and in 2002, only 7,134 kg A.I. sold to the domestic aquaculture industry. The combined total is 32,540.48 kg A.I. (71,752 lbs) sold in 2001 and 24,475 kg A.I. (53,967 lbs) sold in 2002.

Introduction

The prevalence of human bacterial pathogens resistant to antibiotics has increased over time raising concern that the use of antibiotics in animal agriculture might be contributory to this problem (Singer et al. 2003). Proving a direct connection is difficult because of various technical or experimental limitations (Isaacson and Torrence, 2002). Yet, the absence of credible data fosters speculation (Mellon et al. 2001; Benbrook, 2002) that can sway public policy and cause consumer fear. This is certainly true regarding perceptions about the public health and environmental impacts of antibiotic use in domestic aquaculture.

Various non-peer reviewed literature has been published (Angulo, 2000) or made available on the internet (Benbrook, 2002) that raises the specter of significant public health impacts or wide abuse of antibiotics in the domestic aquaculture industry. For example Benbrook (2002) has speculated that the domestic aquaculture industry uses antibiotics prophylactically or as growth promoters. The consequence, according to Benbrook (2002), is that a significant volume of antibiotics (conservatively estimated at 196,408 kg (433,000 lbs) A.I. per year is used. Others (MacMillan, 2001) have argued the volume of antibiotics used domestically is only about 31,746 kg (70,000 lbs) and that the use of antibiotics in the domestic aquaculture industry has a negligible environmental and public health impact. These later volume (31,746 kg) estimates were based on a survey of the major domestic fish feed manufacturing companies in the US in 2001.

Use of antibiotics in the US

In the US, there are two CVM approved and available antimicrobials for use in aquaculture but their approvals are limited to specific food fish (catfish, salmonids and lobster) and specific diseases. These antimicrobials are oxytetracycline (Terramycin[®] for Fish; oxytetracycline monoalkyl trimethyl ammonium) and a potentiated sulfonamide (Romet-30[®]; ormetoprim: sulfadimethoxine). These drugs can only be administered through feed in a specific feed formulation. A third antimicrobial is approved, sulfamerazine, but is not currently manufactured by the sponsor, Alpharma Animal Health. The species and use limitations on these drugs exist because the safety of the antimicrobial in the approved aquatic animals, their effectiveness to cure the diseases they are approved for and their environmental safety have been satisfactorily demonstrated by the drug sponsor.

Terramycin[®] for Fish is the trade name for the only approved oxytetracycline product for use in aquaculture and it is approved to treat only certain diseases in catfish, salmonids and lobster. Oxytetracycline medicated feed can be used to treat bacterial hemorrhagic septicemia and pseudomonas disease in catfish at a dose of 2.5-3.75 g/100 lb of fish/day for 10 days when the water temperature is above 62° F (16.7° C). For salmonids, when the water temperature is above 48.2° F (9° C), Terramycin[®] for Fish can be used to control ulcer disease, furunculosis, bacterial hemorrhagic septicemia and pseudomonas disease using the same dose and duration as for catfish. Terramycin[®] for Fish is not currently approved for use in salmonids at temperatures below 9° C although efforts are ongoing to provide data that could ultimately lead to CVM approval for use at these colder water temperatures. Lobster can be treated with Terramycin[®] for Fish to cure the bacterial disease gaffkemia. The treatment duration is only 5 days at 1 g/lb of medicated feed. This product has a withdrawal time of 21 days for catfish and salmonids and 30 days for lobster. The CVM withdrawal time is the period between the last administration of the drug to the aquatic animal and the time when the aquatic animal can be harvested and offered for food (human or animal). The withdrawal time ensures no harmful drug residues are present when the animal is harvested for human consumption.

Romet-30[®] can be used in medicated feed to treat enteric septicemia of catfish and furunculosis in salmonids. The dose is 50 mg/kg body weight/day for five days. In catfish there is a 3-day mandatory withdrawal time and for salmonids, a 42-day withdrawal time. The shorter withdrawal time for catfish occurs because any Romet-30 residues that might be present are removed with the skin of catfish during processing.

There is only one approved antibiotic for ornamental fish (Nifurpirinol: Furanace Caps), for treatment of columnaris disease in freshwater aquarium fish that are not reproducing and none for other non-food aquatic animals.

It is illegal to use antibiotics prophylactically to prevent aquatic animal disease or for production purposes such as to promote aquatic animal growth. Top dressing feed with an antimicrobial (adding the antibiotic on top of the animal's normal rations) is specifically not permitted. Antibiotics have not been approved for hauling tanks or for immersion treatment of aquatic animals.

The extra-label use of medicated feed (i.e., antibiotics) in aquaculture is limited to medicated feed products approved for use in aquatic species; thus, no other oral antibiotic can be used at the present time other than the approved medicated feeds for Romet-30[®] and Terramycin for Fish[®] (CVM 2001).

Since there are so few (only two) antibiotics available in the domestic food animal aquaculture industry and these have such limited approved uses, the domestic aquaculture industry sectors has focused on alternative fish health management tools. These include the development of vaccines and increasingly, the use of immunostimulants such as β -glucan.

Volume Estimate

Because of the nature and very limited size of the domestic US aquaculture industry, we are able to determine very reliably the volume of antibiotics used per year. While there are three antimicrobials approved by CVM for the domestic food fish aquaculture industry, only two are available (oxytetracycline and ormetoprim: sulfadimethoxine). There is only one manufacturer of oxytetracycline (Phibro Animal Health, Fairfield, NJ) and one manufacturer of ormetoprim: sulfadimethoxine (Alpharma Animal Health Division, Fort Lee, NJ).

Given this unique circumstance, we can fairly easily estimate the quantity of antibiotic used in the domestic industry by asking the two pharmaceutical companies the quantity of active ingredient sold to the domestic aquaculture feed industry. This has now been done. In the 25 month period from January 2001 to February 2003, there was 36,126 kg of ormetoprim: sulfadimethoxine active ingredient (A.I.) sold (Kohan 2003). Averaged out, the amount sold per year was 17,340.48 kg of ormetoprim:sulfadimethoxine as active ingredient. In 2001 there was 15,200 kg A.I. of oxytetracycline sold and in 2002, only 7,134 kg A.I. sold to the domestic aquaculture industry (Knightly 2003). The combined

total is 32,540.48 kg A.I. (71,752 lbs) sold in 2001 and 24,475 kg A.I. (53,966 lbs) sold in 2002. Presumably the volume sold is equivalent to the volume used.

Inquiry of pharmaceutical companies offers the most direct and reliable method to determine the volume of antibiotics sold and presumably used in the domestic aquaculture industry but it does not capture the totality of use. Some, albeit minor use, occurs when medicated feeds are purchased in Canada for use in the US aquaculture industry. Sowles (2003) reports that in Maine, 6.7 kg AI oxytetracycline (2002) up to 349 kg A.I. oxytetracycline (2001) was used in the Atlantic salmon industry. All but 50 kg A.I. was purchased in medicated feed manufactured in Canada. Since January 2001, Maine has required monthly electronic reporting of medications and pesticides used by all salmon farmers.

These data suggest the volume of antibiotic used in the domestic aquaculture industry is very low compared to estimated volumes used in other agriculture industry sectors (Mellon et al. 2001; Carneval 2001). Carneval (2001) surveyed pharmaceutical companies to estimate the total volume of antibiotics used in animal agriculture for all purposes. In 1999, a total of 8.44 million kg of antibiotic active ingredients and 1.33 million kg of tetracyclines were used in US animal agriculture. While not directly comparable because of timing differences, domestic aquaculture represents only about 0.3-0.4 % of the total antibiotics used and 0.5-1.14 % of the total tetracyclines used in US animal agriculture. The volume of active ingredients reported sold to the domestic aquaculture industry by manufacturer representatives is far less than speculative reports suggest. Benbrook (2002) estimated a volume up to 433,000 lbs A.I. was used per year by the domestic aquaculture industry and clearly this grossly overestimates the amount used.

Significance of antibiotic use

The environmental and public health significance of the two antibiotics used in the domestic farm raised food fish industry is not known. The significance is dependent upon a number of factors including environmental fate and the probability that human pathogens might become resistant to the particular antibiotic or class of antibiotics. There is currently no data available to demonstrate a direct link between the use of either antibiotic in fish farming and the occurrence, even rarely, of human pathogens resistant to that particular antibiotic. There are also no publicly available reports to suggest that antibiotic residues occur in domestic farm raised fishes marketed for human consumption. MacMillan (2001) provides reasons why the public health significance of antibiotic use in the domestic industry is thought to be negligible.

Only very limited data exists documenting the concentration of antibiotic in water as a consequence of the use of antibiotic medicated feed. Some data has recently been collected regarding the concentration of antibiotics discharged from flow-through water raceways (Thurman et al. 2002). These studies documented very low (0-2.3 µg/L) concentrations of oxytetracycline or ormetoprim:sulfadimethoxine (0-15 µg/L) in raceway discharge waters of public hatcheries using medicated feeds to treat sick fish.

The frequency of medicated feed use was not documented. It is not clear what type of waste management systems were in place at these facilities. It is believed that the type of waste treatment system utilized may impact the concentration of antibiotics in discharge water. The environmental significance of these concentrations was not investigated.

Studies are underway to determine the potential impact of oxytetracycline in the environment. The USGS's Upper Midwest Environmental Sciences Center (UMESC) is writing an amended environmental assessment for the use of oxytetracycline as an oral drug for use in US aquaculture. As part of the assessment, UMESC is developing dispersion and fate models to predict environmental concentrations of oxytetracycline resulting from use at public and commercial hatcheries. The UMESC has also developed and validated a predictive model for waterborne drugs (e.g., immersion oxytetracycline) discharged from hatcheries into public waters. The proposed model currently is being reviewed by CVM (Gaikowski 2003).

References

- Angulo F. 2000. Alliance for Prudent Use of Antibiotics News. 18(1): 1-6.
- Benbrook, C. M. 2002. Antibiotic drug use in U.S. aquaculture: information available on the World Wide Web, accessed April 24, 2002 at URL <http://www.iatp.org>.
- Carnevale, R. 2001. Practical considerations in the collection of antibiotic use data in animals. A U.S. perspective. Animal Health Institute.
- Center for Veterinary Medicine. 2001. Extra-label use of medicated feeds for minor species. Compliance Policy Guide 615.115. 6 pp.
- Gaikowski, M.P. 2003. Personal communication. Upper Midwest Environmental Sciences Center, LaCrosse, WI.
- Isaacson, R. and M. Torrence. 2002. Role of antibiotics in agriculture. American Acad. of Microbiology. 24 p.
- Knightly, E. 2003. personal communication. PhiBro Animal Health, Fort Lee, NJ
- Kohan, G. 2003. personal communication. Alpharma Health Division, Fort Lee, NJ.
- MacMillan, J.R. 2001. Aquaculture and antibiotic resistance: a negligible public health risk? World Aquaculture 32(2): 49-51, 68.
- Mellon, M., C. Benbrook, and K.L. Benbrook. 2001. Hogging it: estimates of antimicrobial abuse in livestock. Cambridge, MA: Union of Concerned Scientists.

Singer, R.S., R. Finch, H.C. Wegener, R. Bywater, J. Walters and M. Lipsitch. 2003. Antibiotic resistance- the interplay between antibiotic use in animals and human beings. World Wide Web. Lancet: Infectious Diseases 3(1) Forum. Accessed Jan. 27, 2003 at URL <http://infection.thelancet.com/search/search.isa>.

Sowles, J. 2003. Personal communication. Director Ecology Division, Maine Department of Marine Resources, West Boothbay Harbor, ME

Thurman, E.M., J.E. Dietz and E.A. Scribner. 2002. Occurrence of antibiotics in water from fish hatcheries. USGS Fact Sheet 120-02. November 2002.