North Central Regional
Aquaculture Center

In cooperation with USDA

Use and Application of Salt in Aquaculture

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Background

Salt is one of the most commonly used drugs in aquaculture. In fact, it is sometimes referred to as the aspirin of aquaculture.

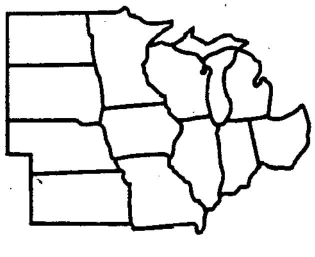
Salt, or sodium chloride (NaC1) in its chemical form, is a drug of low regulatory priority for the United States Food & Drug Administration and requires no withdraw-d time before marketing.

Many forms of salt are used, including table, meat-curing, pickling, and rock salt. Of these, the most commonly used and least expensive form is the meat-curing variety. When used properly, salt can treat many external parasites including *Costia, Epistylis, Trichodina, Chilodonella,* and the flukes Dactylogyrus and Gyrodactylus. Salt is used to relieve stresss during handling and transport.

A few general guidelines are suggested before any salt treatment is attempted:

1. Use sensitive and accurate scales to calculate doses for treatment of small volumes of water contained in hauling or holding tanks. "Guesstimating" may only end in disaster.
2. Know the volume of your ponds, airways, tanks, etc., beforehand. It is advisable to have those values in a convenient location for immediate use.
3. Perform a test treatment on a few fish before attempting a large-scale treatment. Salt, like other chemicals, reacts differently among different species and water qualities.
4. Prepare to remove fish or flush out salt baths with fresh water when fish show initial signs of stress.

Treatment procedures involve calculating the volume of water to be treated, calculating salt dosage, and choosing the treatment method. In the case of a specific disease, the corresponding rate of salt for applications needs to recalculated.



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Treatment Methods

The method of salt application depends on the disease organism, fish species, weight, and type of aquaculture unit. Treatment methods include short-term dips, prolonged baths, and indefinite treatments.

Dip treatments involve exposing the fish to very strong solutions for short periods of time, usually 30 seconds to one minute.

Prolonged baths are useful for heating fish in small tanks that can be flushed quickly. Strong solutions of salt are added to the water. Fish are held in this salt solution with aeration from 30 to 60 minutes, or until they show signs of stress.

Indefinite treatments are used when-transporting, handling fish, or when dealing with large volumes of water, such as ponds. Low concentrations of salt can be used indefinitely in ponds.

Calculation of Volumes

Calculating tank and pond volume is an important step to effective salt application in aquaculture. Measurements used to determine volume are usually in feet and/or inches. The most common shapes of culture tanks, ponds, or raceways are square, rectangular, or round.

Square or rectangular pond and tank volumes are calculated similarly except that an average depth is used for ponds. The method used to calculate volume of each is given below.

Volume of a square or rectangular raceway, tank or pond.
Volume (Vol.) = Length x width x depth

Example 1: A rectangular tank is 12 feet (ft.) long, 3 ft. wide and 3 ft. deep. What is its volume?
vol. =12 ft.x 3 ft. x 3 ft.
Vol. = 108 cubic ft. (ft.^{3})

Volume of a round tank
Vol. = 3.14x (radius x radius) x depth

Example 2: A round tank is 12 ft. in diameter and 4.5 ft. deep. What is its volume? (Radius = 0.5 x diameter)
Vol. = 3.14 x (radius x radius) x depth
Vol. = 3.14 X (6 ft. x 6 ft.) x 4.5 ft.
Vol. = 3.14 X 36 ft.^{2} x 4.5 ft.
Vol. = 508.7 ft.^{3}

Table 1. Specific treatments and methods of using salt for treating various diseases or as a remedial treatment of stress.

Disease	Concentration and duration of treatment for control of disease
External parasites of brood fish	30,000 ppm (3%) as quick dip (15 seconds) before stocking
External parasites *Costia, Epistylis, Trichodina,* and *Chilodonella* and the flukes Dactylogyrus and *Gyrodactylus*	10,000-30,000 ppm (l-3%) prolonged treatment (30 minutes or until fish show signs of . stress) or 1,000-2000 ppm in hauling tanks as an indefinite treatment
Stress during transport and while handling	Indefinite treatment using 1,000-10,000 ppm (0.1-1.0%)

Calculation of dosages

Once the volume is calculated in cubic feet, the gallons are determined using these conversions:
1 ft^3 = 7.48 gallons (gal.)
1 acre-foot (1 surface acre x 1 ft. deep) = 325,850 gal.
1 liter (L)= 0.26 gal.

Other useful conversions:
1 pound (lb.)= 454 grams (g)
1,000 g = 1 kilogram (kg)

One of the most commonly used units of measure in aquaculture is the part per million, commonly referred to as ppm. In percentage calculations, 1% equals 10,000 ppm. The amount of salt added to various volumes that results in 1 ppm concentrations is listed below.
1 ppm equals:
2.7 lb./acre-foot
0.0283 g/ft.^{3}
0.00378 g/gal.
1.0 milligram (mg)/L

Example 3: How much salt is needed to make a 2% solution using a prolonged treatment for *Dactogyrus in* the round tank used in Example 2?
2.0% = 20,000 ppm
tank volume (gal.) = 508.7 ft^3 x 7.48 gal./ft^3 = 3,805.1 gal.
salt needed(g) = 0.00378g/gal. x 3,805.1 gal. x 20,000 = 287,663g or 633.6 lbs. ($\frac{287,663g}{454g/lb.}$ = 633.6 lbs.)

Example 4: How much salt is needed to make a 0.570 solution using an indefinite treatment in a 100-gal. transport tank?
0.5% = 5,000 ppm
Salt needed(g) = 0.00378 g/gal. x 100 gal. x 5,000 ppm
Salt needed(g) = 1,890 g or 4.2 lbs. ($\frac{1890g}{454g/lb}$ = 4.2 lbs.)

Specific treatment rates

Specific treatments using salt are given in Table 1.

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METHODS OF ADMINISTERING TREATMENT CHEMICALS IN WATER

It has been said that treating fish diseases with water-administered chemicals has killed more fish than did the disease being treated. The most common cause of this is overdosing, which is usually the result of inadequate planning.

Descriptions of methods for treating fish with external infections of protozoa, metazoa and bacteria often do not include methods of administering the chemicals in intensively managed systems; i.e., systems having high water flows and fish densities.

All treatments must include a bioassay to establish the proper dose and duration of treatment. The process is quite straightforward. For example, a population of rainbow trout is affected by *Gyrodactylus* and formalin is selected as the chemical to be used. The approach is:

1. Prepare at least three 10-15 liter concentrations of the selected chemical. Measure 10-15 liters of water from the pond to be treated into each of three plastic buckets. The three concentrations of formalin - 1:4,000, 1:5,000, and 1:6,000 - are prepared; i.e., 1 ml:4,000 ml. Provide aeration to each bucket.

2. Place 2-3 clinically ill and 2-3 clinically healthy fish into each bucket. The usual duration of treatment is 60 minutes during which the fish are monitored for signs of toxicity.

3. At the end of the treatment period examine the clinically affected fish for the presence of the organism.

4. The concentration to be administered is that which did not affect the fish negatively and killed the infecting pathogen.

At this point the pond characteristics, the amount of formalin to administer, and the method of administration are considered.

For a 60-minute static bath treatment in a trough or rectangular pond:

1. Calculate water volume

$$V = L * W * D$$

Where: V = water volume (ft^3 or m^3)
L = total length (ft or m)
W = total width (ft or m)
D = total depth (ft or m)

2. Calculate water volume displaced by fish

$$V_f = W / 1.018$$

Where: V_f = water volume (l) displaced by fish

W	=	biomass (kg) of fish
1.018	=	kg of fish displacing 1.0 l water

3. Calculate amount of required medicament

$M = ((V - V_f) * R_x)$

Where: M = grams or ml medicament to be administered

V = total water volume (liters)

V_f = water volume displaced (liters) by fish

R_x = mg/l concentration of medicament required

Example

1. Fish: rainbow trout; 40/lb; 7,5000 lb
   Pond: raceway; 100' long; 10' wide; 3' deep
   Water: 950 gpm inflow
   Medicament: 0.2 ml/l formalin for 60 minutes via static bath method

2. Calculate total water volume

   100 * 10 * 3* = 3,000 ft_3

   3,000 * 28.32 = 84,960 liters

3. Calculate water volume displaced by fish:

   (1.018 kg fish displace 1.0 liter water)

   7,500 / 2.2 = 3,401.9 kg

   3,401.9 / 1.018 = 3,341.7 liters

4. Calculate treatment volume

   84,960 - 3,341.7 = 81,618.3 liters

5. Calculate the amount of medicament to be delivered

   0.2 * 81,618.3 / 1000 = 16,323.7 ml (<u>16.3 liters</u>)

6. Shut off the water inflow and provide supplemental aeration

7. Dilute 16.3 l of formalin in 40-50 l water

8. Distribute the solution as evenly as possible through the pond

9. Monitor the pond for signs of toxicity or discomfort for 60 minutes

10. If clinical signs of toxicity occur: (1) pull the sump; (2) start the water inflow; (3) provide additional water.

11. Examine a few fish within 18-24 hours for efficacy.

For a 60-minute drip treatment in a flow-through rectangular pond:

1. Calculate the amount of medicament to be administered:

   $R_{xt} = V_w * R_x * 60$

   Where:
   - R_{xt} = total amount of medicament (ml or mg)
   - V_w = water volume (l) - volume displaced by the fish (l)
   - R_x = dosage (ml/l or mg/l)
   - 60 = minutes per hour

<u>Example</u>

a. Fish: rainbow trout; 40/lb; 7,500 lb
   Pond: raceway; 100; long; 10' wide; 3' deep
   Water: 950 gpm inflow
   Medicament: 0.2 ml/l formalin for 60 minutes via continuous drip

b. Calculate the water volume (liters) to be treated:

   Total water volume: 3,000 ft^3 x 28.32 = 84,960 liters

   Water volume displaced by fish: 3,341.7 liters

   84,960 - 3,341.7 = 81,618.3 liters to be treated

c. Calculate the amount of medicament required

   81,618.3 * 0.2 = 16,323.7 ml

   16,323.7 / 60 = <u>272 ml/minute</u>

d. Dilute 16.3 liters of formalin to 60 liters of water.

e. Set up the drip container to deliver 1.0 lpm

f. Initiate the treatment

g. Monitor the progress; i.e., signs of toxicity, at 10-15 minute intervals

h. Discontinue treatment if signs of toxicity appear.

i. Examine 2-3 fish 18-24 hours after treatment to evaluate efficacy.

j. Re-treat if necessary.

For a 60-minute drip treatment in ponds having circulating water patterns:

1. Calculate the water volume:

Square-end (Burrows) pond

$$V = (L * W * D) - (L_w * T_w * D_w))$$

Where:			
	V	=	water volume (ft^3 or m^3)
	L	=	total length (ft or m)
	W	=	total width (ft or m)
	D	=	total depth (ft or m)
	L_w	=	length of center wall (ft or m)
	T_w	=	thickness of center wall (ft or m)
	D_w	=	depth of center wall (ft or m)

Round-end pond

$$V = ((3.1415927 * R^2 * D) + (L * W * D)) - (L_w * T_w * D_w)$$

Where:			
	V	=	water volume (ft^3 or m^3)
	R	=	radius of the D-end (ft or m)
	D	=	water depth of the D-end (ft or m)
	L	=	length of the rectangular portion (ft or m)
	W	=	width of the rectangular portion (ft or m)
	D	=	depth of the rectangular portion (ft or m)
	L_w	=	length of center wall (ft or m)
	T_w	=	thickness of center wall (ft or m)
	D_w	=	depth of center wall (ft or m)

Circular pond

$$V = 3.1415927 * R^2 * D$$

Where:			
	V	=	water volume (ft^3 or m^3)
	R	=	radius (ft or m)
	D	=	depth (ft or m)

2. Calculate the medicament depletion time:

Rectangular ponds

$$T_d = ((-V / R_w) * \ln 0.5) / 60$$

Where:			
	T_d	=	50% medicament depletion time (minutes)
	V	=	water volume (ft^3 or m^3)
	R_w	=	water inflow (cfs or m^3ps)
	0.5	=	percent (10^{-2}) reduction of medicament
	60	=	seconds per minute

Circular ponds:

$T_d = ((-V / R_w) * (\ln 0.5 / 1.830)) / 60$

Where: T_d = 50% medicament depletion time (minutes)
V = water volume (ft^3 or m^3)
R_w = water inflow (cfs or m^3ps)
0.5 = percent (10^{-2}) reduction of medicament
60 = seconds per minute
1.830 = mixing coefficient

Example

a. Fish: rainbow trout; 5/lb; 20,100 lb
Pond: rectangular circulating D-end; 100' over-all; 20' wide; 3' deep; center wall 90' long; 1' thick
Water:500 gpm inflow
Medicament: 0.2 ml/l formalin constant exposure for 60 minutes

b. Calculate total water volume.

$((3.1415927 * 10^2 * 3) + (20 * 80 * 3)) - (90 * 3)$
$= (942.48 + 4{,}800) - 360 = 5{,}382.48\ ft^3$

5,382.48 * 28.32 = 152,431.83 liters

c. Calculate the water displaced by the fish.

20,100 lb = 9,117.2 kg

9,117.2 / 1.018 = 8,956.0 liters

d. Calculate the treatment volume.

152431.83 - 8,956.0 = 143,475.8 liters

143,475.8 / 1000 = 143.5 m^3

e. Calculate the amount of medicament required for the initial dose.

143,475.8 * 0.2 = 28,695.2 ml

f. Calculate the 50% depletion time of the medicament.

((-143.5 / 0.0316) * -0.693) / 60) = 52.45 minutes

g. Calculate the amount of medicament discharged per minute (50% of the required dose / minutes required for depletion = dosage to be administered per minute).

14,347.6 / 52.45 = 273.5 ml

h. Calculate the amount of medicament discharged in 60 minutes (equal to the total dose to be administered).

   273.5 * 60 = 16,412.8 ml

i. Dilute the 28.7 l of the medicament in 40-50 liters of water.

j. Distribute the medicament solution as evenly as possible throughout the pond.

k. Dilute 16.4 l of the medicament in 60 liters of water for drip delivery at the rate of 1.0 lpm

l. Monitor the progress; i.e., signs of toxicity, at 10-15 minute intervals.

m. Discontinue the treatment if signs of toxicity appear.

n. Examine 2-3 fish 18-24 hours after treatment to evaluate efficacy and re-treat if necessary.

Prepared by G.W. Klontz, Technical Services Advisor to Nelson and Sons, Inc.

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Medicated Feed For Food Fish

Robert M. Durborow[1] and Ruth Francis-Floyd[2]

Bacteria are tiny, single-celled organisms which are continually present in the water, soil, and air. Most bacteria are beneficial (e.g., they help digest foods and break down ammonia, nitrite, and organic debris in the environment). There are a number of different bacteria that cause disease in cultured freshwater food fish such as catfish, salmon, and trout. In aquaculture, many bacterial diseases of fish can be successfully treated with medicated feeds. However, **prevention** through good management practices is the best control measure for bacterial diseases.

Bacterial diseases of fish are usually a result of stress such as overcrowding. Avoiding these stressors often reduces disease incidence. Failing to correct stressful conditions while treating sick fish with medicated feed will usually either prevent the medication from being effective or will cause the disease to recur after the treatment is completed.

Bacterial disease

Some bacteria are considered **opportunistic pathogens**. These bacteria are often present in the water and inside the fish, and they usually cause no problem. In nature fish are, in most cases, resistant to these pathogens and can seek the best living conditions available.

In aquaculture, however, food fish are weakened by stress conditions including increased fish density, inadequate nutrition, poor water quality (i.e., low dissolved oxygen, or high ammonia and nitrite), parasite infestation, and handling. Stress suppresses the immune system, increasing the fish's susceptibility to bacterial infections. As a result, cultured food fish are more susceptible to disease than free-ranging animals. Common examples of opportunistic bacteria which can cause disease and death of food fish include: *Aeromonas hydrophila*, *Cytophaga (Flexibacter) columnaris*, and *Pseudomonas fluorescens*.

Some bacteria are considered **obligate pathogens**. They can be the sole cause of disease even in the absence of stressors. *Aeromonas salmonicida*, *Edwardsiella ictaluri*, *Renibacterium salmoninarum*, and *Yersinia ruckeri* are considered by some to be obligate pathogens.

Medicated feed

Medicated feed is frequently recommended to control bacterial disease outbreaks. Medicated feeds contain an antibiotic and are usually commercially prepared. Antibiotics are drugs that can be taken internally to control bacterial infections. They do not control parasites, fungus, or viruses. Fish often stop eating as a bacterial disease progresses, so early diagnosis and treatment are essential to ensure that infected fish consume the medicated feed. Once a bacterial disease is detected, and if medicated feed is the appropriate treatment, the feed should be used immediately.

If medicated feed is not readily available in your area, it may be advisable to special order a few bags to keep on hand, stored in a cool, dry place. Delivery of feed may take a few days to more than a week, which will delay treatment and jeopardize the health of the fish.

There are many different types of antibiotics, but the Food and Drug Administration (FDA) has

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approved only two for use in food fish. These are **Terramycin®** (Pfizer, U.S. Animal Health Operations, New York, NY) and **Romet®** (Hoffman-LaRoche, Inc., Nutley, NJ). Older literature lists Sulfamerazine® for the treatment of diseased fish, but it is no longer available. Each is discussed separately below.

Regardless of the antibiotic feed used, treatments should always be the maximum recommended dose and should be fed for the total number of days recommended even if the fish appear to have recovered. Feeding lower concentrations of antibiotics or decreasing the number of days the drug is fed can allow the bacterial pathogens to develop a resistance to the antibiotic. The antibiotic, then, would not be able to control certain infections that may occur later at your fish farm or hatchery.

Terramycin®

Terramycin® has been used for treatment of food fish for many years. It contains the drug **oxytetracycline**. This drug is usually effective against many bacteria which cause disease in food fish. The FDA specifically approved Terramycin® for control of *Aeromonas hydrophila (A. liquefaciens)* and *Pseudomonas* sp. infections in catfish and *Aeromonas salmonicida, A. salmonicida achromogens (Haemophilus piscium), A. hydrophila (A. liquefaciens)* and *Pseudomonas* sp. in trout. *A. hydrophila* causes motile aeromonas septicemia, *A. salmonicida* causes furunculosis, and *A. salmonicida achromogens* causes ulcerative disease in trout and goldfish. Terramycin® is incorporated into the feed by commercial mills and fed at a rate of 3.75 grams (g) of the drug per 100 pounds of fish per day.

Terramycin® must be fed for 10 days to control the infection. The fish must be held for an additional 21 days before they can be marketed for food to allow complete elimination of the drug from the fish. Marketing fish for human consumption before the end of the 21-day **withdrawal period** is a violation of federal law. As a result, marketing plans must be considered before treating fish with Terramycin®. Once treated, fish cannot be sold for at least 31 days (10-day treatment period plus 21-day withdrawal period).

An additional consideration when feeding Terramycin® is that it is only available from commercial mills as a sinking feed. The drug is broken down by the higher temperatures needed to make an extruded (floating) pellet. Feeding a sinking food is a major disadvantage for sick pond fish because it is difficult to determine if they are eating the medicated feed.

Romet®

Romet® (Romet-30®, Romet-B®) is also approved for use in both trout and catfish as well as in salmon. This product contains two drugs, **sulfadimethoxine** and **ormetoprim**. These drugs in combination are more effective than either drug used alone. Romet® is specifically approved for treatment of *Edwardsiella ictaluri* infections in catfish and *Aeromonas salmonicida* infections in trout and salmon. *E. ictaluri* causes enteric septicemia of catfish.

Romet® medicated feed is produced by commercial feed mills and should be fed at a dosage of 23 milligrams (mg) of drug per pound of fish (50 mg of drug per kilogram of fish) per day for 5 days. If the feed contains 33.3 pounds of Romet-30® premix per ton, then the fish need to consume at least 1 percent of their body weight to achieve a therapeutic dose of the drug. At varying Romet® concentrations, the proper feeding rate can easily be calculated. For example, feed mixed with 11.1 pounds of Romet-30® per ton of feed should be fed at 3 percent of body weight.

The withdrawal period for Romet® is only 3 days for channel catfish. This is considerably less than for Terramycin®. With a 5-day treatment period and a 3-day withdrawal period, catfish treated with Romet® can be slaughtered only eight days after the drug treatment is initiated. Trout, however, are required to have a 42-day withdrawal period from Romet® before being slaughtered.

Another advantage of Romet® is its availability from commercial mills in a **floating pellet**. This allows direct pond observation of the fish eating the medicated feed.

Selecting the proper medication

To optimize the response to antibiotics provided in feed, producers should correct other problems which may have predisposed fish to the bacterial infection. This should include checking water quality parameters and submitting proper fish and water samples to a diagnostic laboratory. If the fish have a bacterial disease and the causative agent has been identified, a sensitivity test should be performed to ensure that the correct medication is used. A sensitivity test (Figure 1) shows the resistance of the disease-causing bacteria to various antibiotics. If bacteria are unable to grow in the presence of a particular antibiotic, a **zone of inhibition** or clear area is present surrounding the area treated with that drug. If the drug has no effect on the bacteria, they will grow up to or over the top of the disc.

Figure 1. A sensitivity test shows the resistance of the disease-causing bacteria to various antibiotics.

A fish health professional or disease diagnostic laboratory can perform the sensitivity test for you and recommend an antibiotic to be used. Remember, there are circumstances when treatment with an antibiotic is unnecessary or ineffective. Some bacterial diseases cannot be controlled with medicated feed. For example, there is currently no antibiotic available that is truly effective against *Renibacterium salmoninarum* which causes bacterial kidney disease in salmonids.

Economics and other factors also help to determine the appropriateness of using medicated feed. A farmer with a 1-acre pond stocked with 1,000 1/2-pound fish, for example, would probably be wise to spend an extra $50 to $85 on medicated feed (cost will depend on the type of antibiotic and source of feed) if he were losing $10-worth of fish each day. On the other hand, if he were only losing $2-worth of fish a day and a qualified fish health professional does not think that the mortalities will continue for a month, then spending $70 for a medicated feed treatment may not be economically wise.

Treatment strategies

The basic objective of treating fish is to save money for the producer. One must make sure, for example, that the cost of treatment does not exceed the value of the fish in the pond! If possible, expensive treatments should be avoided unless they are likely to save money for the fish farmer in the long run. A good example is the treatment strategy for ESC caused by *Edwardsiella ictaluri*. This disease occurs when temperatures are between 68 and 82ºF when the bacteria is in its optimum growth range. Fish dying from ESC will usually stop dying as temperatures rise above or fall below this temperature range. Starting affected fish on a medicated feed treatment just before temperatures are forecast to be in the 90s, for example, is often not advised, because the disease stops on its own due to the high temperatures. Using this strategy will save a significant amount of money by not spending for the medicated feed.

Homemade medicated feeds

If commercial medicated feed is not readily available in your area, it is possible under emergency circumstances to mix your own feed in small quantities. Both Terramycin® and Romet® can be used in this manner. FDA approval and/or an extra-label prescription by a veterinarian are necessary before using this treatment.

The powdered premix is combined with the binder and then added to the feed. A 5 percent gelatin solution as well as vegetable or fish oil work well as binders. The feed and antibiotic must be mixed thoroughly to assure even distribution of the drug to all the pellets. The coated feed should then be spread out to air dry. After several hours of drying, the feed can be re-bagged and stored under proper conditions. This is an expensive and time-consuming process that is practical only if commercial medicated feed is unavailable and relatively small quantities of medicated feed are required. In addition, a significant quantity of the antibiotic may leach out of the homemade medicated feeds before being consumed by the sick fish. Many producers feel, however, that the homemade treatment is better than none when formulated medicated feeds are not available.

Terramycin® premix may be purchased as a soluble Terramycin powder at many agricultural supply stores. A. 6.4-ounce packet usually contains 10 grams of oxytetracycline, but check the label to be sure.

Two packets of Terramycin® can be added to a 5-gallon bucket full of feed (approximately 17 pounds of feed). If the fish consume the feed at 3 percent of their body weight, they will receive the needed therapeutic dose of antibiotic. If the fish are eating less than 3 percent of their body weight, then more than 2 packets of Terramycin® will be needed. A qualified fish health professional or veterinarian can be contacted for help in calculating the appropriate quantity of medication needed.

Romet® is available in powdered premix called Romet-B®. A disadvantage of Romet-B® is that it is only available in 25-pound canisters, which may be too expensive to be practical for small farmers.

The amount of feed that will fill a 5 gallon bucket (about 17 pounds of feed) should be mixed with Romet-B® powder using the number of grams from the table below depending on the amount of feed that the fish will consume (based on % of the fish's body weight).

Storage of medicated feed

As with all fish food, medicated feed should be stored in a cool, dry place. If available, a freezer is ideal for storing fish feed for extended periods. Antibiotics and essential nutrients will deteriorate rapidly in a warm, moist environ-

Feed Eaten by Fish (% of Body Weight)	Grams of Romet-B® to mix with 5-gallon bucket full of feed (17 pounds)
1	172
2	86
3	57
4	43
5	34

ment. Excessive decomposition of antibiotics as a result of improper storage can result in unsuccessful treatment. Discard unused medicated feed after 4 months at room temperature.

Use of medicated feed in alternative species

Antibiotics are approved for use only in catfish, salmonids, and lobsters. At this time, the FDA is considering approval of Terramycin® for striped bass and hybrid striped bass. Extensive tests demonstrating both the effectiveness and safety of each drug are required for each species of food fish and each disease to be treated. These tests are very expensive and usually require years of experimental trials. Few drug companies can afford to spend the money needed for the approval process because of the small returns expected from the aquaculture industry as compared to traditional agriculture. Universities, however, are participating in this essential testing process to aid the aquaculture industry.

At the time of this writing, FDA will allow veterinarians to prescribe the use of medicated feed for fish species other than those listed on the label. For example, Terramycin® medicated feed approved for use in catfish may be prescribed extra-labelly for hybrid striped bass by a licensed veterinarian. Check with a qualified fish health professional or veterinarian on the current status of medicated feed use regulations before treating your fish.

Summary

Medicated feed is frequently recommended to control bacterial disease outbreaks. Medicated feed is a fish diet containing an antibiotic.

Bacterial infections may be controlled by antibiotics. Only two antibiotics are available in medicated feeds for food fish.

Terramycin® contains the drug oxytetracycline. The FDA specifically approved Terramycin® for control of *Aeromonas hydrophila* and *Pseudomonas* sp. infections in catfish and *Aeromonas salmonicida, A. salmonicida achromogens (Haemophilus piscium), A. hydrophila (A. liquefaciens)*, and *Pseudomonas* sp. in trout. Terramycin® should be fed for at least 10 days, followed by a 21-day withdrawal period. It is only available in a sinking pellet.

Romet® is a combination of two drugs, sulfadimethoxine and ormetoprim, that together are more effective than using either chemical alone. It is approved by the FDA for treatment of *Edwardsiella ictaluri* infections in catfish and *Aeromonas salmonicida* infections in salmonids. Romet® should be fed for at least 5 days followed by a 3-day withdrawal period for catfish. Trout, however, are required to have a 42-day withdrawal period from Romet® before being slaughtered. Because Romet® is available commercially in a floating pellet, this allows for pond observation of the fish eating the medicated feed.

If the fish have a bacterial disease and the causative agent has been identified, a sensitivity test should be performed by a fish health professional to ensure that the correct medication is used. A sensitivity test shows the resistance of the disease-causing bacteria to various antibiotics.

Regardless of the antibiotic feed used, treatments should always be the maximum recommended dose and should be fed for the total number of days recommended even if the fish appear to have recovered. Feeding lower concentrations of antibiotics or decreasing the number of days the drug is fed can allow the bacterial pathogens to develop a resistance to the antibiotic. The antibiotic, then, would not be able to control certain infections that may occur later at your fish farm or hatchery.

Bacterial diseases are often a consequence of poor water quality, improper nutrition, excessive parasitism, or improper handling. These management problems must be corrected for successful, long-term control of infections.

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