FA37

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Use of Potassium Permanganate to Control External Infections of Ornamental Fish [1]

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Introduction

Many disease problems of ornamental fish begin as external infections. If uncontrolled, the infections may become systemic, resulting in death of the fish. Correct use of potassium permanganate can effectively control many bacterial, parasitic and fungal agents before systemic infections become established, often eliminating the need for antibiotic therapy. The fish owner saves money because use of expensive antibiotics is decreased, thereby decreasing the incidence of resistant bacterial strains. In the ornamental trade, correct use of potassium permanganate at the onset of an infection can also speed the movement of fish as they do not need to be held for lengthy (often 10–14 day) antibiotic treatments.

What is Potassium Permanganate?

Potassium permanganate ($KMnO_4$) is an oxidizing agent that has been used for many years in aquaculture. It is also used in water conditioning systems and in the plumbing industry. As an oxidizer, it is able to chemically "burn up" organic material. This includes undesirable organic matter such as bacteria, parasites, and fungus, as well as desirable material such as gill tissue and mucus. Because the chemical cannot distinguish between desirable and undesirable organic matter, it is up to the individual to use the chemical in a manner that results in maximum benefit and minimum harm to treated fish.

Color Change Associated with Potassium Permanganate Use

When potassium permanganate is active (in its unoxidized form), treated water turns a pinkish-purple color. As the chemical is "deactivated" (by oxidizing organic material), the water color changes to yellow or muddy brown. This color change is an important tool when monitoring chemical treatment (discussed below); however, this may make potassium permanganate undesirable for use in display tanks, exhibits, or ornamental ponds. As with many chemicals used in water, potassium permanganate is harmful to plants and invertebrates.

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Use of Potassium Permanganate

For most fish, potassium permanganate can be administered at a concentration of 2 mg/L as a long-term bath (four-hour minimum) in fresh water or salt water systems. Potassium permanganate is also reasonably safe to use in recirculating systems and has minimal impact on biofilters when used at 2 mg/L. Treated water should retain the purple coloration for at least four hours.

There is extensive information on the use of potassium permangante in freshwater systems, but much less is known about its effect in marine systems. Fish culturists should run a small bioassay before treating marine fish.

Some fish, including certain Lake Malawi cichlids, are sensitive to potassium permanganate and lower concentrations (1 mg/L) may be safer. A small experiment run by the authors on a cichlid production facility in southeast Florida demonstrated that 2 mg/L $KMnO_4$ for four hours was safe for common cichlids. The fish owner can determine species sensitivity by observing the behavior of the fish during treatment. This is especially important when treating a species for the first time. If fish react adversely, immediate action (such as diluting the chemical with fresh water) should be taken.

Because potassium permanganate is deactivated by organic matter, it may be necessary to increase the amount added to ponds or other systems where organic material has been allowed to accumulate. A safe way of accomplishing this is to add potassium permanganate to the system in 2 mg/L increments. If water color changes from purple to brown in less than four hours from the start of the first treatment, an additional 2 mg/L should be added. If a total application of 6 mg/L potassium permanganate does not result in maintenance of the purple color for at least four hours, the system should be cleaned. Most of the organisms that are treated with potassium permanganate thrive in an organically rich environment; therefore, improved sanitation can have a tremendous impact on treatment efficacy.

Potassium permanganate can also be used as a short-term bath at concentrations of 10 mg/L for 30 minutes. At this concentration, careful observation of fish is mandatory to avoid mortality. This is a convenient treatment when fish are being removed from ponds and brought into buildings for sorting and shipping. Following a potassium permanganate treatment with a low concentration (2–10 ppt) of salt (sodium chloride) as a semipermanent treatment for several days or weeks (depending on species treated), can be beneficial. This combination is particularly effective in minimizing Columnaris infections (see UF/IFAS Fact Sheet FA-11, *Columnaris Disease*) after handling fish.

Potassium permanganate can be used as a surface disinfectant at concentrations of 10 mg/L (30–60 minutes contact time) to 500 mg/L (30 seconds contact time) in a fish room or hatchery, however, quaternary ammonium compounds are better suited to this purpose. Potassium permanganate will kill bacterial, fungal and many parasitic agents, but it is not viricidal.

Frequency of Treatment

As mentioned above, potassium permanganate is an indiscriminate oxidizer, and as such, can burn gill tissue and mucus of treated fish if too much chemical is applied. A good rule of thumb to prevent excessive damage to fish is to avoid treating them with potassium permanganate more than once a week. If a chemical treatment is needed for a condition that requires more frequent application, such as treatment for an outbreak of "Ich" (*Ichthyophthirius multifiliis*, see UF/IFAS Extension Circular 920), potassium permanganate is not a good choice.

Treatment Failure

Poor efficacy following use of potassium permanganate is usually caused by one of three factors: (1) incorrect or incomplete diagnosis; (2) incorrect calculation or measurement of amount of chemical needed; and (3) excessive organic material in the system resulting in rapid degradation of the chemical. Any time treatment failure occurs, sick fish should be submitted to a diagnostic laboratory for an accurate diagnosis. Volume of the water treated, accuracy of calculations to determine treatment rate, and accurate measurement (by weight) of chemical used are essential for delivery of an appropriate chemical dose. As mentioned above, an excessive

amount of organic matter in the system will result in rapid deactivation of potassium permanganate, and therefore contact time with active chemical will be inadequate for effective treatment. This is often a problem in heavily stocked ponds.

Determining the Amount of Potassium Permanganate to Use

To calculate the amount of chemical required, a simple formula can be used:

Amount of Chemical = Volume x Conversion Factor x Treatment Rate

If the pond or tank volume is measured in gallons, the conversion factor is 0.0038 and the answer will be given in grams (see Table 1 for other conversion factors).

For a treatment rate of 2 mg/L, this formula would be:

Grams of Chemical = Gallons Treated x 0.0038 x 2 mg/L

Therefore, to treat a 250-gallon vat, the grams of potassium permanganate needed are:

Grams needed = (250 gal) x (0.0038) x (2 mg/L) = 1.9 grams

An inexpensive gram scale can be obtained by purchasing a dietary scale at your local grocery store or pharmacy. One level teaspoon of potassium permanganate weighs about 7.0 grams.

Table 1. Common Conversion Factors for Use in Calculation of Amount of Chemical to Use in a Unit Volume of Water for a Concentration of 1 ppm (1 mg/L).

Units	Conversion Factor
grams/gallon	0.0038
pounds/acre-foot	2.72
grams/cubic foot	0.0283
pounds/cubic foot	0.000062

Use of a Stock Solution

An alternative method of measuring potassium permanganate is to mix a stock solution. A stock solution is a concentrated solution of chemical from which small amounts can be taken to treat tanks as needed. This is useful when either multiple tanks or multiple treatments are needed. An easy way to make up a stock solution for potassium permanganate is to purchase a one-gallon bottle of distilled water, weigh 285 grams of potassium permanganate, add it to the solution, and mix thoroughly. This stock solution will deliver a dose of 1 mg/L when delivered at a rate of one drop per gallon. Therefore, to achieve the desired concentration of 2 mg/L, the stock solution can be delivered at a rate of two drops per gallon. The stock solution should be stored in a cool, dark area and be replaced annually.

When treating larger systems, it is useful to remember that 20 drops are equal to 1 milliliter (ml), or one cubic centimeter (cc) if measuring the liquid with a syringe. Therefore, 1 ml of stock solution will treat ten gallons of water with a concentration of 2 mg/L.

Safety Precautions When Handling Potassium Permanganate

Potassium permanganate is fairly safe to handle, however, all chemicals should be treated with respect. Potassium permanganate will easily stain clothing and skin. Brown discoloration of skin is not painful, but it may be unsightly and takes several days to disappear. Brown stains to clothing can be permanent. Protective eye wear, gloves and clothing are recommended when handling potassium permanganate.

Fish farmers and aquarists do occasionally mix chemicals. It is important that formalin and potassium permanganate are **NEVER** mixed as the combination can be explosive.

Summary

Potassium permanganate is an oxidizer which can be used to "disinfect" the external surfaces of fish. It effectively removes most external parasites, as well as fungal and bacterial agents. Most fish can

be treated by prolonged immersion in a 2 mg/L potassium permanganate solution (water must retain a purple color for at least four hours), although some species may be sensitive to it and may not tolerate a full strength (2 mg/L) bath. Because of its harsh oxidizing properties, potassium permanganate should not be applied to fish more frequently than once per week or mortality may result. It is safe to use in marine and recirculating systems at 2 mg/L. Potassium permanganate can stain skin and clothing so care is suggested when handling it. The chemical should **NEVER** be mixed directly with formalin as an explosion or fire could result.