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TESTING PLANT MATERIALS FOR DETECTION OF OXYGEN-DEFICIENT WATER IN PONDS[1]

by

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CONTENTS

Abstract

An easy method of determining the extent of oxygen deficiency in ponds, using the staining qualities of plant materials, is described. Woods, barks, leaves and fruits of many kinds of plants stain dark in pond water that contains less than approximately 0.2 ppm dissolved oxygen, whereas they do not stain in well-aerated water. Stain results from the reaction of ferrous iron in the water with tannic acid in plant materials. Suitable woods stained within 10 to 15 minutes in laboratory tests, and within 30 to 45 minutes in pond tests. Both fresh and dried materials stained in oxygen-deficient pond water.

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[1]Reprinted from Proceedings of the FAO World Symposium on Warm-water Pond Fish Culture Rome, Italy, 18-25 May 1966: FAO Fish. Rep. '44) Vol. 4 1968

VI/E-1

ESSAIS DE MATIERES VEGETALES SERVANT A DECELER L'INSUFFISANCE EN OXYGENE DE L'EAU DES ETANGS

Résumé

Description d'une méthode facile permettant de déterminer, grâce à la faculté de coloration de certains végétaux, le degré d'insuffisance en oxygène des étangs. Le bois, l'écorce les feuilles et les fruits de nombreuses espèces végetales prennent une teinte sombre lorsqu'ils sont immergés dans une eau contenant moins d'environ 0,2 ppm d'oxygène dissous, alors qu'ils ne changent pas de couleur dans une eau bien aérée. Le phénomène de coloration est dû à une réaction que se produit lorsque les composés ferreux de l'eau sont mis en présence de l'acide tannique contenu dans les matières végétales. Des morceaux de bois appropriés se sont colorés au bout de 10 à 15 minutes lors d'essais en laboratoire, et au bout de 30 à 45 minutes lors d'essais en étang. La coloration s'obtient aussi bien avec des matériaux frais qu'avec des matériaux secs dans les eaux déficitaires en oxygène.

ENSAYO DE MATERIALES VEGETALES PARA LA DETECCION DE LA DEFICIENCIA DE OXIGENO EN EL AGUA DE LOS ESTANQUES

Extracto

Se describe un método fácil para determinar el grado de desoxigenación de los estanques, utilizando las propiedades colorantes de los materiales vegetales. Las maderas cortezas, hojas y frutas de muchas clases de plantas dan un color oscuro al agua de los estanques que contiene menos de 0,2 pp, aproximadamente de oxígeno disuelto, en tanto que no coloran las aguas bien aireadas. La coloración procede de la reacción de los compuestos ferrosos que hay en el agua con el ácido tánico existente en los materiales vegetales. Algunas maderas adecuadas dieron color al cabo de 10 a 15 minutos en los ensayos de laboratorio y de 30 a 45 minutos en los ensayos en estanques. El agua con suficiente oxígeno fué colorada tanto por materiales frescos como secos.

1 INTRODUCTION

Many fish culturists have experienced kills of fish as a result of oxygen-deficiency in ponds. Knowledge of oxygen-deficiency beforehand could have enabled pond owners to save fish populations in numerous instances. While fisheries biologists can detect oxygen-depletion in ponds, most pond owners have neither the training nor the equipment to carry out the necessary tests.

Dendy (1965) reported that anaerobic water stained certain woods, but well-aerated water did not. This work provided pond owners a method for determining depths to which dissolved oxygen is distributed in ponds. Approximately 50 kinds of North American woods were tested for staining in anaerobic waters. The results varied from excellent to unsatisfactory. Desirable woods stained within 30 to 45 minutes.

The chemical basis of staining is the reaction of tannic acid in the wood with ferrous iron in waters that are anaerobic or have no more than approximately 0.2 ppm of oxygen. This soluble form of iron changes to insoluble ferric iron in well-aerated water, which does not react with tannic acid.

This paper describes the testing of plant materials to determine their suitability in detecting oxygen-deficient water in ponds.

2 CHEMISTRY OF PONDS

Stratification of water in ponds is common, especially during hot weather when there is little or no wind. When water that is oxygenated from the air and from photosynthesis does not circulate throughout the pond, the deeper layers develop a shortage of oxygen. In fertile waters containing blooms of phytoplankton, the zone of well-oxygenated water often becomes relatively shallow. During nights the supply of oxygen may be reduced to such low concentrations that fish have too little oxygen for respiration. Fish culturists can often save their fish by pumping surface water into the air and letting it fall back into the pond. This drives additional air into the pond and helps circulate the water. If pumps are not available, outboard motors or various manual methods may be used to stir the water and cause circulation in small ponds.

Whatever the method of stirring may be, there is always the question of when it is needed. If the pond owner waits until fish are in distress, or begin to die, losses may be considerable before the conditions can be corrected. The purpose of this paper is to describe how pond owners may avoid fish kills by determining the extent of anaerobic water in ponds before conditions become dangerous to fish.

3 MATERIALS

3.1 Tannic acid

Many plants throughout the world contain tannic acid. It may be found in such parts of the plants as barks, leaves, fruits, and woods. Howes (1953) lists many plants of various regions that have tannic acid in quantities sufficient to be of commercial value in the leather industry. The amounts of tannic acid in some plants may be too small for use in the leather industry, but are highly satisfactory for staining reaction in ponds. For this use the plant material should be light in colour and possess enough tannic acid to produce a conspicuous stain.

3.2 Water with ferrous iron dissolved in it

Most ponds have sufficient iron in them for testing. However, the pond must be deep and fertile enough to develop anaerobic or almost anaerobic conditions to have iron in soluble ferrous form.

4 TESTING PLANT MATERIALS

4.1 Laboratory tests

To test which local plant materials can be used, list plants and prepare thin shavings of wood, bark, small twigs, petioles of leaves, and veins of leaves. Dried materials are desirable and can be stored for subsequent use. Since fresh material frequently stains well it too should be tested. Crushed fresh leaves of some plants stain where the tissues have been broken. Dried tea leaves contain tannic acid, but may be too dark to show stain distinctly. Fresh leaves should be tried. The thinness is important. The feather-edge of a wood shaving shows staining more readily than do thicker parts. If very thin shavings are not available, the thin fibres of broken and of small pieces will suffice.

Prepare a fresh solution of ferrous sulphate (0.5 to 1.0 g per l of water). This solution will be usable for a few hours.

Use pairs of glass or porcelain containers with well-aerated water in one and ferrous sulphate solution in the other. Approximately 25 ml of water or solution will be ample. Immerse one piece of plant material in water and a similar piece in ferrous sulphate solution. Staining may be quite noticeable within one minute if the material is highly suitable but 10 to 15 minutes of exposure should be allowed before terminating the test. Slight stirring of the liquid will hasten the staining.

After a period of exposure, remove the material from water to determine the wet but unstained colour. Then, remove the material from the ferrous sulphate solution to determine the presence of stain. Useful material will show an obvious darkening. If the woody substance is light coloured and contains a sufficient amount of tannic acid, the stain will be a dark purplish blue.

The tannic acid from some plant material tends to dissolve into solution, causing it to become discoloured, especially fresh material that contains a high concentration of tannic acid.

4.2 Pond tests

After laboratory tests have been made, select the material that stained well, and a pond that is relatively deep and fertile. Tie a weight on one end of a string, and attach small pieces of the material at intervals of approximately 0.1 metre. Lower the weight into the water until it reaches the bottom, and then tie the string to a float or other support to ensure that the string is held in a vertical position. Allow 30 to 45 minutes for staining to take place. Remove the string and compare the colours of the plant materials. A dark purplish blue stain indicates a lack of oxygen in the water to which the material has been exposed. Faint darkening results when approximately 0.2 ppm of oxygen is present. Differences in colour can be distinguished easily by comparing an unstained piece of plant that was exposed in the aerated water near the surface with a piece that was exposed in anaerobic deep water.

4.3 Pond tests without previous laboratory tests

Tie a weight to the end of a string. At approximately 0.1 m above the weight attach several labelled pieces of different plant materials. At a position on the string that will be approximately 0.1 m beneath the surface attach similar labelled pieces. Expose the samples for 30 to 45 minutes and then remove from the water to compare staining. If staining occurs on certain woods they are suitable for further tests and the pond is suitable for further tests at 0.1 m intervals. If no staining occurs other plant materials should be tested, or the water of that pond contains dissolved oxygen at all depths, and another pond should be used for the tests.

5 DISCUSSION

Preliminary tests should be made by fisheries biologists who can check their results by use of standard chemical analyses. They will find that water with enough oxygen to support fish does not stain the plant materials. However, it must be remembered that the absence of stain does not indicate an abundance of oxygen. Even a concentration of 0.5 ppm of oxygen produces no stain.

When the change from dark stain to no stain occurs within approximately 0.2 m the water of the upper layers is usually well-aerated. When the change from dark stain to no stain extends through a layer 1 to 2 m thick, the layer immediately above probably contains relatively little oxygen. If water that stains the wood slightly is within 1 m of the surface this should be considered a danger signal, especially if half or more of the volume of water is at depths that produce stain.

6 RECOMMENDATIONS

Fisheries biologists should determine the suitability of locally available plant materials for use by pond owners. Then the use should be demonstrated to pond owners. Emphasis should be made on the inexpensiveness and simplicity of the technique.

Pond owners should keep a supply of desirable plant material. It is important that ponds be tested frequently during periods of hot weather and little wind.

Tests should be conducted at dawn, the period when oxygen is minimal. Remedial stirring must be started promptly if staining indicates the beginning of oxygen deficiency near the surface.

If a desirable kind of wood is available in lengths somewhat greater than the depth of the pond, a piece can be marked at 0.1 m intervals and be held in place by pushing one end into the bottom of the pond. After the period of exposure in water, the wood is examined for stain. A stained piece of wood can be reused after trimming one side. One piece of wood a few centimetres thick will be adequate for many tests.

7 REFERENCES

Dendy, J.S., 1965 Use of woods to determine the depths of oxygen distribution in ponds. Progr. Fish Cult., 27(2): 75-8

Howes. F.N., 1953 Vegetable tanning materials. London, Butterworth Scientific Publications, 325 p

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