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THE BLOOD LACTIC ACID LEVELS OF CARP IN THE DIFFERENT ENVIRONMENTS

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Introduction

The properties of fish blood are influenced by environmental conditions. It is well known that a fish shows acidosis under certain conditions.

There are two kinds of acidosis. One is the respiratory acidosis caused by a respiratory factor such as the increase of carbon dioxide tension in the blood and the other is metabolic acidosis caused by a metabolic factor such as the accumulation of organic acid.

According to many investigations showing the importance of lactic acid in relation to acid-base balance, it was assumed that the blood lactic acid level was closely related to the condition of metabolism in the fish.

The blood lactic acid levels of carp in different environments were determined to see the influence of environment on the metabolism in the fish.

Materials and Methods

The species of fish used in this work was a carp *Cyprinus carpio* LINNE of 92~155 mm in body length, 18.0~79.2 g in body weight. The carps were obtained from a pond of a private fish farm in the suburbs of Sendai City, Miyagi Prefecture and were tamed in the aquarium in our laboratory for at least a week before the experiment.

The suffocation of carp was caused by using an airtight vinyl bag filled with 300 ml. water or solution. In other experiments, the carp was allowed to stand in the four litre solution.

During the experiment, the water temperature was in the range of 15~19°C.

Blood was drawn from the heart into a hypodermic syringe rinsed with 10% sodium citrate solution and 0.3 ml of blood was used to determine the lactic acid. The blood lactic acid level was determined by a Barker-Summerson's method (1).

Results and Discussions

All the results are shown in Fig. 1. Hydrogen-ion concentrations and total CO₂ contents are quoted from our previous report (2) and are listed in Table 1.

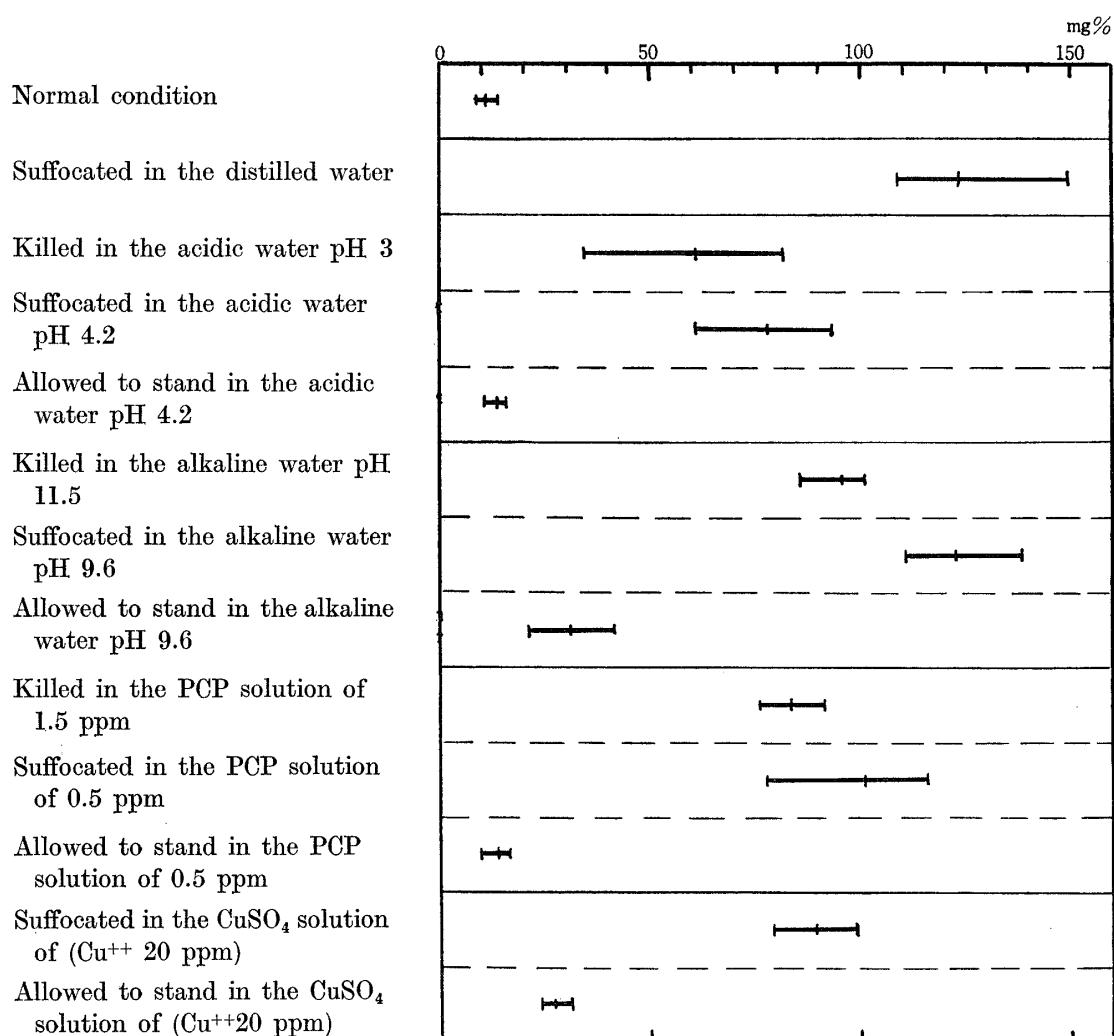


Fig. 1. The blood lactic acid levels of carp in the different environments.

Normal condition

The blood lactic acid level of carp at a water temperature between 15 and 19°C was in the range 9.1~13.6 mg%, average value 11.1 mg%. It was near the value of 8 ± 2.98 mg% which Black (3) obtained in the carp at a water temperature between 11.5 and 12°C.

Suffocation in the distilled water

The blood lactic acid level of carp suffocated to death in the distilled water in 150 to 230 minutes was in the range 109.1~149.4 mg%, average value 123.0 mg%. It increased remarkably and reached about 12 times as high as that in normal condition.

Kokubo (4) reported that under the suffocative state the value of pH and the carbon dioxide tension in fish blood became lower than those in the normal condition. Similar results to those were obtained in the preceding report (2).

Table 1. Hydrogen-ion concentrations and total CO₂ values of carp-blood in the different environments

Condition	Range of pH	Average pH	Range of total CO ₂ meq/l blood	Average total CO ₂ meq/l blood
Normal condition	7.62-7.70	7.67	19.6-29.8	23.1
Suffocated in the distilled water	6.12-6.60	6.31	11.1-16.4	13.7
Killed in the acidic water pH 3	6.70-7.18	6.87	16.5-24.2	20.3
Suffocated in the acidic water pH 4.2	6.45-6.71	6.57	23.4-25.0	24.4
Killed in the alkaline water pH 11.5	6.70-7.22	6.73	10.0-12.0	11.2
Suffocated in the alkaline water pH 9.6	6.55-6.80	6.61	9.6-13.9	12.6
Allowed to stand in the alkaline water pH 9.6	7.70-8.00	7.85	21.6-25.2	23.6
Allowed to stand in the CuSO ₄ solu. (Cu ⁺⁺ 12.5ppm)	7.2-7.42	7.30	18.6-28.3	21.8
Killed in the PCP solu. 1.5ppm	6.47-6.61	6.55	17.3-21.5	19.7
Allowed to stand in the PCP solu. 0.5ppm	7.12-7.80	7.60	24.0-33.5	28.8

From the above results, acidosis of fish under the suffocative state seems to be owing to the increase in organic acid such as lactic acid in the blood.

The decrease of the blood corpuscle resistance of carp in dyspnoea was reported by Kariya (5, 6).

It also probably was owing to the remarkable accumulation of lactic acid in the blood in common sucker observed by Black and Irving (7), that a level between 150 and 400 mg% lactic acid caused hemolysis *in vitro*.

Acidic water

In the case of the carp killed in 90 to 105 minutes in the water adjusted to pH 3 with H₂SO₄, its blood lactic acid level was in the range 34.3~82.3 mg%, average value 61.0 mg%. Although the carp did not exercise violently, it showed near the value of 54.3±4.49 mg% which Black (3) obtained in the carp exercised for 15 minutes. The blood of carp killed in this water probably showed acidosis.

When the carp was suffocated to death in 180 minutes in the water adjusted to pH 4.2 with H₂SO₄, its blood lactic acid level was in the range 61.0~81.0 mg%, average value 78.4 mg%. It was lower than that in the distilled water. The blood in this case probably showed acidosis (Table 1).

In the carp allowed to stand for 180 minutes in the water adjusted to pH 4.2, its blood lactic acid level was in the range 10.1~16.2 mg%, average value 13.4 mg% and was nearly the same value as that in normal condition.

Alkaline water

In the case of the carp killed in 90 to 110 minutes in the water adjusted to pH 11.6 with NaOH, its blood lactic acid level was in the range 85.5~100.8 mg%, average value 96.2mg%. In spite of the strong basic water, it was higher than that killed in the water of pH 3 and the blood even in this case probably showed acidosis (Table 1).

The blood lactic acid level of a carp suffocated to death in 150 to 170 minutes in the water adjusted to pH 9.6 with NaOH was in the range 110.1~138.1 mg%, average value 122.4 mg%. It was almost the same value as that of the carp suffocated to death in the distilled water. Acidosis could be seen in this carp.

In the carp allowed to stand for 150 minutes in the water of pH 9.6, its blood lactic acid level was in the range 20.6~41.5 mg%, average value 30.4 mg%. It was nearly three times as high as that in the normal condition. The blood, however, probably showed alkalosis (Table 1). Alkalosis in this condition agreed with the finding of Kokubo (4).

PCP solution

PCP (Pentachlorophenol) is a herbicide which has a severe toxicant to fishes and its 48 hours T.L.M. of the carp is about 0.15 ppm.

In the case of the carp killed in 105 to 145 minutes with the 1.5 ppm PCP solutions, its blood lactic acid level was in the range 79.1~91.5 mg%, average value 83.0 mg%.

Acidosis could be seen in this case (Table 1).

In the case of the carp suffocated to death in 180 to 240 minutes in the 0.2 ppm PCP solution, its blood lactic acid level was 78.0~115.9 mg%, average value 100.4 mg%.

The blood lactic acid level of the carp allowed to stand for 240 minutes in the 0.2 ppm PCP solution was in the range 9.6~15.5 mg%, average value 13.0 mg% and was nearly the same value as that in the normal condition.

CuSO₄ solution

The blood lactic acid level of the carp suffocated to death in about 150 minutes in the CuSO₄ (Cu⁺⁺ 20 ppm) solution was in the range 79.1~99.6 mg%, average value 89.4 mg%. It has been said that the cause of death of fish in the CuSO₄ solution is suffocation. The low value, however, compared with that of carp suffocated in the distilled water suggests that there may be causes of death other than suffocation.

In the carp allowed to stand for 150 minutes under the same condition, its blood lactic acid level was in the range 23.7~30.9 mg%, average value 27.2 mg%.

The conclusions based on the above results are as follows.

The decrease of blood corpuscle resistance and acidosis in the carp under the suffocative state can probably be caused by the remarkable accumulation of organic acid, especially lactic acid in the blood.

The blood lactic acid level of carp facing death will likely be higher than that of carp exercised violently and it will be the highest if the carp suffocated.

It is known that the increase of the blood lactic acid level cause the unbalance of demand and supply of oxygen in blood or organs.

The increase of blood lactic acid level of carp exercised violently results from the excess of O₂ consumption of carp according to the exercise, whereas that of carp suffocated results from the decrease in O₂ intake of carp according to the decrease in O₂ tension in the environment.

We observed that the blood lactic acid level of carp suffocated to death in the distilled water was higher than that of carp killed with certain poisonous factors in addition to suffocation.

It therefore will be possible to demonstrate the absence of poisonous factors in the environment by means of the determination of the blood lactic acid level of carp suffocated to death.

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