Effect of Simulated CO$_2$ Leakage on Blood Indicators of Crucian carps in Water

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Abstract

Aquatic animals are important components of aquatic ecosystems such as lakes, swamps and reservoirs. Their normal growth and development are important signs of the healthy development of aquatic ecosystems. The blood components of fish are not only the result of their reaction to the aquatic environment, but also the premise of their intrinsic physiological changes. CCS (Carbon Dioxide Capture and Storage) is an important measure to combat climate change. Due to the defects of its projects, however, it may result in the release of sequestered CO$_2$ into aquatic ecosystems, and affecting ecosystems represented by fish.

By breeding aquarium and blood gas analysis method, the impact on the blood gas of crucian carp at different CO$_2$ flow were studied in this paper. The main conclusions were obtained as follows:

(1) In the injection of CO$_2$ conditions, the blood pH of all experimental groups were higher than that of control group. With the increasing of CO$_2$ concentration, crucian carp tended to adapt gradually. When the CO$_2$ aeration increased to 100ml/min, the pH of the experimental groups fluctuated near the pH value of CK group. This showed that, even in high flow of CO$_2$, the crucian carp can adapt to the change of pH in water through its own compensation mechanism.

(2) In the injection of CO$_2$ conditions, the dioxide oxygen partial pressure (PaCO$_2$) of experimental groups were overall higher than the control group. With the increase of CO$_2$ flux and time, PaCO$_2$ and its fluctuation of crucian carp blood increased. In particular, when the carbon dioxide aeration rate exceed 80ml / min, PaCO$_2$ first decreased and then fluctuated greatly. The possible reason was that too much carbon dioxide caused a temporary closure of the gill gas exchange, and this temporary closure still didn’t counteract the impact of carbon dioxide.

(3) The oxygen partial pressure (PO$_2$) in the blood of the experimental groups were higher than that of the control group. Under hypoxic conditions, crucian carp increased its oxygen partial pressure slightly by increasing the number of red blood cells and the oxygen carrying capacity of haemoglobin. When the CO$_2$ concentration were from 20ml/min to 80ml/min, and the CO$_2$ injection time were less than 72h, the PO$_2$ of crucian carp blood fluctuated between 3-6mmHg. When the CO$_2$ concentration increased to 100ml/min or injection time was longer than 72h, PO$_2$ of crucian carp increased obviously because of the hypoxia compensation mechanism stimulated by CO$_2$.

(4) The concentrations of Ca$^{2+}$ and K$^+$ in the crucian carp of the experimental groups were lower than those in the control group. When CO$_2$ concentration increased from 20ml/min to 80ml/min, the

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concentrations of Ca\textsuperscript{2+} and K\textsuperscript{+} gradually approached the level of the CK group, which may be the result of the humoral regulation. Ca\textsuperscript{2+} in crucian carp fluctuated obviously when the CO\textsubscript{2} concentration increased to 100ml/min in which over-high CO\textsubscript{2} concentration prevented the exchange of H-Ca and H-K and resulted in disorder of humoral regulation. Na\textsuperscript{+} concentration in the experimental groups were higher than that in the control group. When CO\textsubscript{2} concentration were less than 80ml/min, the concentrations of Na\textsuperscript{+} gradually approached the level of the CK group by the humoral regulation. But when the CO\textsubscript{2} concentration was increased to 100ml/min, the Na\textsuperscript{+} fluctuated obviously in which over-high CO\textsubscript{2} concentration resulted in the disorder of humoral regulation of crucian carp.

(5) The lactic acid content of crucian carp in the experimental groups were lower than that of the control group (4 mml/L). In particular, when the CO\textsubscript{2} influx were greater than 40 ml/min, the lactic acid content in the blood of the crucian carp reduced sharply and fluctuated at a concentration of 1 mml/L. The reason may be under hypoxic conditions, the lactic acid produced in the anaerobic glycolysis were directly decomposed to ethanol through the anaerobic metabolism.

(6) The difference between the actual bicarbonate ion content (AB) and the standard bicarbonate ion content (SB) were always greater than zero, i.e. CO\textsubscript{2} in water can caused respiratory acidosis or metabolic alkalosis of the crucian carp.

**Keywords:** CCS; CO\textsubscript{2}; crucian carp; blood indicators.