The trial of the sturgeon efficient culture using the micro-nano bubble to the recirculating aquaculture system

Kiyoshi Hiraoka [1)] * , Chiyumi Tsuchiya [2)], Takehiko Nakajima [1)], Katsumasa Yamashita [1)], Sachiyo Hanyu [1)] , and Uhei Naruse [2)]

1)Fujikin Inc. 18 Miyukigaoka, Tsukuba, Ibaraki, 305-0841 Japan

2)Kamakura Women's University, 6-1-3 Ofuna, Kamakura, Kanagawa, 247-8512 Japan

ABSTRACT

This study investigated whether the application of micro-nano bubbles (MNB) in a Recirculating Aquaculture System (RAS) could result in significant improvement of the sturgeon breeding environment. An experiment using oxygen MNB showed that injecting oxygen into micro-nano bubbles improved the physiological development of fish, raising the growth rate while heightening the resolution of the nitrifying-bacteria. Extrapolating further, MNB would appear to benefit aquaculture management by effectively forcing dirt down to the bottom of the tank.

INTRODUCTION

Microbubbles are distinguished by size of <50 μm diameter as well as important technical applications due to their ability to decrease in size and subsequently to collapse under water (Fig.1.). Some features of Micro-nano bubbles include: (1) Bubbles can remain underwater for long periods, and can improve gas dissolution efficiency.
(2) Bubbles spread throughout a tank and do not cause anaerobic conditions underwater.
(3) Bubbles can permeate in fish and can improve cell activity. While it is hypothesized that bubbles can induce high growth in fish, experimental data on this effect of micro-nano bubbles have been lacking. In this study, in addition to the effects of micro-nano bubbles on fish growth, effects on water quality and the nitrifying-bacteria group that exists in an aquaculture system were also investigated.

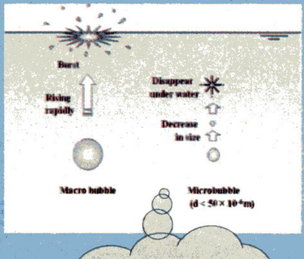


Fig.1. Microbubble behavior. The ordinary macrobubbles rose rapidly and burst at the water's surface. By contrast, the microbubbles decreased in size and disappeared under the water.

What are Micro-nano bubbles?

Fig.3. Micro-nanobubble generator. This device generates micro and nano bubbles by injecting compressed gas through porous ceramic material. The manufacturer of this device has developed a technique for making extremely small, "nano-sized" pores in the ceramic material.

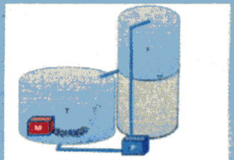


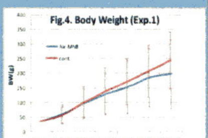
Fig. 2. Simple RAS with MNB.
T: Tank; P: Pump; F: Filter Unit

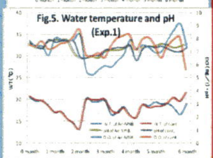
RAS (Recirculating Aquaculture System)
Fish tank: 1t made by polycarbonate
Pump: Discharge 75l/min. Head 3.3m
Filter tank : 0.5t made by FRP
Filter medium: plastic medium and coral sandd

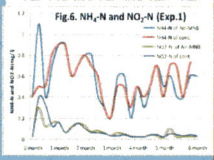
Experiment 1: Air-Micronano bubbles

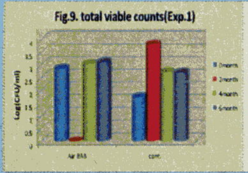
Fish: 90 Bester-F2 0-year-old fish were split into two groups and reared separately in a 1-ton RAS system; the experimental group was subjected to Air-MNB, the control group to normal conditions (Fig. 2).
Term: 6 months
Items measured: Fish growth, water conditions and the nitrifying-bacteria group in the RAS

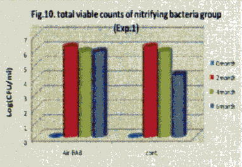
RESULTS:
Growth rate: no significant differences were detected between Air-MNB and control groups（Fig. 4）.
Water conditions: no significant differences in W.T., D.O., pH, NH-4 and NO2-N (Fig. 5, 6). On the other hand, large quantities of moss grew on the surface of the control group tank while very little moss grew on the surface of the Air-MNB group tank (Figs. 7, 8). While the amount of nitrifying bacteria was the same between air-MNB and the control group, the total viable counts within the air-MNB group tended to be less than in the control group (Fig. 9, 10).











Clear!

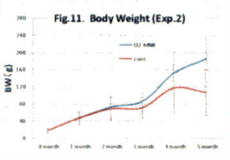
Fig.7. The tank surface of a wall of Air-MNB

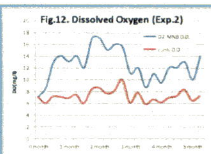
Fig.8. The tank surface of a wall of control

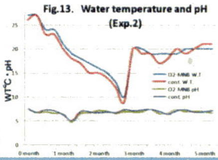
Experiment 2: Oxgen-Micronano bubbles

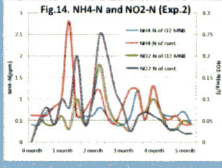
Fish: 90 Bester-F2 0-year-old fish were split into two groups and reared separately for five months in a 1-ton RAS system; the experimental group was subjected to O_2-MNB, the control group to normal conditions (Fig. 2).
Term: 5 months
Items measured: Fish growth, water conditions and the nitrifying-bacteria group in the RAS

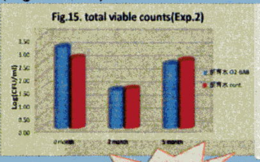
RESULTS:
Sturgeon fry in the O2-MNB environment experienced faster growth over the course of the experiment compared with the control group (0.05>P, Fig. 11). Moreover, during the period, D.O. was 5 mg/L higher than in the control group on average and maintained the super saturation state (Fig. 12). Differences between the two groups were not seen for W.T., pH, and NH_4-N. On the other hand, NO_2-N in the O_2-MNB group was half that of the control group (Fig. 13-16). Moreover, the breeding water in the experimental group tank was visibly more transparent than that of the control group; moss barely adhered to the tank surface of the wall (Figs. 17, 18).

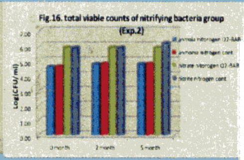












Clear!

Fig.17. The tank surface of a wall of O2-MNB

Fig.18. The tank surface of a wall of control

CONCLUSIONS:

This experiment showed that air bubbles added to the RAS had no effect on the growth rate, whereas the addition of oxygen bubbles had a significant effect on fish growth. Even though the amount of feed also increased as the growth of fish increased, the water quality remained stable although the nitrogen captured by the tank filter was higher than in the control group. Although the researchers expected a rise in the nitrifying-bacteria group in tandem with the increase of dissolved oxygen as well as an increased amount of decomposed excrement, a difference in bacterial count was not found in this investigation. Since the physiological development of the fish increased, it is suggested that oxygen micro-nano bubbles speed up the growth rate **by main enumeration** while heightening the resolution ability of the nitrifying-bacteria group. The experiment also demonstrated benefits to fish rearing management in that the dirt of the tank was pressed down clearly, and it is thought that it is effective in circulation culture.

Air-Micronano bubbles
- ★ Keep poly-carbonate tank clean
- ★Growth rate is equal as conventional bubbling

Oxygen-Micronano bubbles
- ★ High growth rate
- ★ Keep poly-carbonate tank clean
- ★ Keep water condition
- ★ Heighten bacteria activity

Bester F2
Huso huso × Acipenser ruthenus

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