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ARTICLE

Can Application of Commercial Microbial Products Improve Fish Growth and Water Quality in Freshwater Polyculture?

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Abstract

A 31-d experiment was conducted to examine the effects of three commercial microbial products (Novozymes pond plus, Zhongshui BIO-AQUA, and Effective Microorganisms) on production performance and water quality in freshwater tanks stocked with Grass Carp *Ctenopharyngodon idellus*, Gibel Carp *Carassius gibelio* and Silver Carp *Hypophthalmichthys molitrix*. Four treatments were used: blank control (BL), adding Novozymes pond plus (NO), adding BIO-AQUA (PB), or adding Effective Microorganisms (EM). The fish were fed daily with a formulated feed, and each of the microbial products was added to the tanks every 10 d. No significant differences were found in survival, weight gain, and feed conversion ratio of the fishes, Secchi depth, chemical water quality, and phytoplankton between the blank control and any other treatments (NO, PB and EM). This study indicates that the addition of these three microbial products every 10 d has limited function to improve production performance and water quality in freshwater polyculture of Grass Carp, Gibel Carp, and Silver Carp within the first 31 d of application.

[illegible] *Penaeus vannamei* ([illegible] 2005), A [illegible] ([illegible] 2003; B [illegible] 2006; [illegible] 2008). [illegible] *P. monodon* ([illegible] 2009; [illegible] 2001) [illegible] *Paralichthys olivaceus* ([illegible] 2006). [illegible] 2000; [illegible] 2000; B [illegible] 2006; [illegible] *Ictalurus punctatus* (B [illegible] 1984; [illegible] 2009) [illegible] 2006; [illegible] 2008; [illegible] 2008; [illegible] 2009; [illegible] 2009; [illegible] 2010). [illegible] 2009). [illegible] 2002). [illegible]

* [illegible] : [illegible] @ [illegible]
[illegible] 6, 2015; [illegible] 30, 2015

Ctenopharyngodon idella, *Mylopharyngodon piceus*, *Carassius gibelio*, *Cyprinus carpio*, *Hypophthalmichthys molitrix*, *Hypophthalmichthys nobilis*, 1982; 2004; 2015). 2015). 2003; 2010).

METHODS

Microbial products and fish polyculture system. 16 15, 2010. 4°C 16 A-281.0 -2.9 -239.1 -2 7 -6 .2 10 .3 -194.7 -281.5-281.

Sampling, chemical and biological analysis. … 85 … 0600 0800 h … 1600 1800 h … 63 … 3 (0800 1000 h) … 30 50 … 5- … = 1 … 10% … ($_3^{2-}$ … $_3^{-}$), … $^{2+}$ … $^{2+}$), … ($_3$- … $_4{}^{+}$-), … ($_2$-), … ($_3$-), … ($_4$-), … ( ), … ( ) … ( ). B … a (Ch a), … A … $^{2-}$, $^{3-}$, … $_4$-, … Ch a, … 3 . A … 1, 16 … 31. A … $^{2-}$, … $_4$-, … A … A (2005). … (1973). … (1983). Ch a … 10-005 … 100 … ( ). … 1 … 1,000 … 2 h. A … 1 … 0.2-μ … (25- … 110656 … B … (2007). … 80 … ( ).

Calculation and statistical analysis. … (1949) …

$$(\%) = 100 \times N_t/N_0$$

$$(\ /\ h) = (W_t/N_t - W_0/N_0)$$

$$= I/(W_t - W_0)$$

$$(\ /\ ) = C_t - C_0$$

$$= -\sum_{i=1}^{S} P_i \ {}_2 P_i$$

h … N_t … N_0 … W_t … ( ) … W_0 … ( ); I … ( ); C_t … (/) … C_0 … P_i … i … ; S …

… (…) … $^{2-}$, $^{3-}$, $^{4-}$, … (Ch a, …), … (A … A). … ( ) … A … A. A … (A) … Ch a, … $^{2-}$ … $P = 0.05$. … A … A … B … 20.0 (B … A …). … A … 4.5 (…).

RESULTS

… (A … A: $P > 0.05$; … 1). … 26.2°C … 35.4°C (… = 30.1°C, … = 2.4). … ($n = 3$, …) … = 42 50 … = 4.03 4.57 … / , … = 7.73 7.83, … = 94.46 95.73 … C C $_3$/ , … = 98.65 99.24 … C C $_3$/. … $^{2-}$, $^{3-}$ … $^{4-}$, … (A … A: $P > 0.05$; … 2). … $^{4-}$, … (A … A: $P > 0.05$; … 1).

… 51 … (*Merismopedia* ., *Chroococcus* ., *Aphanocapsa* ., *Microcystis* ., *Anabaena* ., *Coelosphaerium* ., *Dactylococcopsis* ., *Nostoc* ., *Spirulina* ., *Oscillatoria* ., *Hammatoidea* ., *Chamydomonas* ., *Volvox* ., *Eudorina* ., *Pan-*

TABLE 1. [illegible] ($n = 3$) [illegible]

[illegible]	[illegible] (h)			(%)			[illegible] (h)			[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	4.9 ± 1.1	8.1 ± 1.0	1.2 ± 0.4	92 ± 0	87 ± 23	78 ± 19	20.3 ± 3.6	17.5 ± 3.7	50.6 ± 10.2	1.46 ± 0.23
[illegible] B	5.3 ± 0.3	9.0 ± 1.1	1.9 ± 1.3	76 ± 25	93 ± 12	67 ± 0	14.2 ± 2.8	16.3 ± 1.9	77.9 ± 16.3	1.94 ± 0.27
[illegible]	4.6 ± 0.4	8.7 ± 1.0	1.7 ± 1.2	83 ± 6	100 ± 0	67 ± 0	14.9 ± 6.8	16.1 ± 1.3	52.0 ± 19.8	1.64 ± 0.30
B	5.4 ± 1.1	8.0 ± 0.9	1.2 ± 0.4	92 ± 0	100 ± 0	56 ± 19	16.0 ± 3.3	16.8 ± 1.4	43.6 ± 28.5	1.47 ± 0.19

dorina ., *Schroederia* ., *Tetraedron* ., *Selenastrum* ., *Kirchneriella* ., *Nephrocytium* ., *Actinastrum* ., *Pediastrum* ., *Ankistrodesmus* ., *Micractinium* ., *Crucigenia* ., *Scenedesmus* ., *Westella* ., *Oocystis* ., *Mougeotia* ., *Spirogyra* ., *Cosmarium* ., *Staurastrum* ., *Arthrodesmus* ., *Euglena* ., *Trachelomonas* ., *Lepocinclis* ., *Phacus* ., *Cryptomonas* ., *Heterotrichales* ., *Synura* ., *Stephanodiscus* ., *Coscinodiscus* ., *Cyclotella* ., *Melosira* ., *Navicula* ., *Frustulia* ., *Cocconeis* ., *Surirella* ., *Synedra* ., *Gymnodinium* ., *Glenodinium* .) [illegible] *Merismopedia* [illegible] *Nostoc* [illegible] *Coelosphaerium* [illegible] 86.6% [illegible] 12.2% [illegible] 1 [illegible] 14 [illegible] 14 [illegible] 31. [illegible] (A [illegible] A: $P > 0.05$; [illegible] 2).

[illegible] *a* [illegible] 1 [illegible] 17, [illegible] (3A). A [illegible] B, [illegible] B [illegible] 17, [illegible] 27, [illegible] (3B). [illegible] *a* [illegible] (A [illegible] A: $P > 0.05$).

[illegible] *a*, [illegible] 2− [illegible]

97.6% [illegible] (A), [illegible] (0.69 [illegible] 0.24, [illegible] 4). [illegible] ($F = 3.51$, $P = 0.046$).

DISCUSSION

[illegible] (< 3 [illegible], < 1 [illegible], < 17 [illegible]).

[illegible] 2000; B [illegible] 2006). [illegible]

TABLE 2. [illegible] ($n = 3$) [illegible] (B); 2− [illegible] 3− [illegible] 4− [illegible]

[illegible]	A (/)	2− (/)	3− (/)	4− (/)	(/)	(/)	[illegible] (/)
[illegible]	0.396 ± 0.290	0.011 ± 0.016	0.023 ± 0.025	0.457 ± 0.391	2.752 ± 1.306	0.804 ± 0.342	16.17 ± 0.89
[illegible] B	0.481 ± 0.246	0.016 ± 0.021	0.022 ± 0.022	0.567 ± 0.496	2.825 ± 1.311	0.940 ± 0.492	16.32 ± 0.13
[illegible]	0.403 ± 0.197	0.013 ± 0.016	0.026 ± 0.032	0.544 ± 0.459	2.956 ± 1.467	0.981 ± 0.470	16.70 ± 0.06
B	0.421 ± 0.232	0.009 ± 0.018	0.025 ± 0.028	0.492 ± 0.395	2.183 ± 1.413	0.881 ± 0.374	16.23 ± 0.60

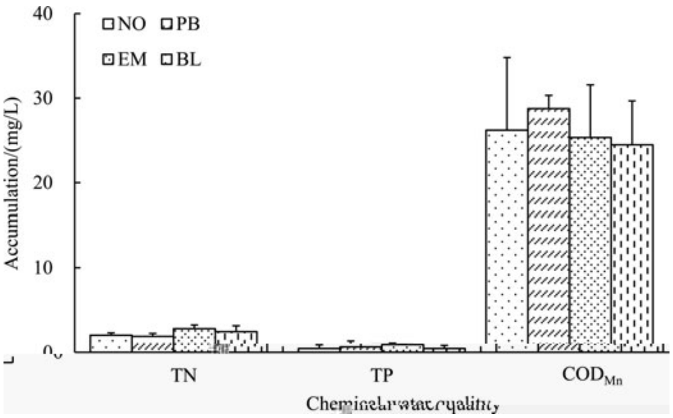


Figure 1. [illegible] (BL [illegible] -A [illegible] A (B), [illegible] (B [illegible]).

[illegible] *Litopenaeus setiferus* ([illegible] 2005; [illegible] 2009) [illegible] (2008). [illegible] ($^{2-}$), [illegible] 1993; [illegible] 2001; [illegible] 2005; [illegible] 2009). [illegible] *Bacillus* [illegible], *Nitrosomonas* [illegible] *Nitrobacter* [illegible] 2000).

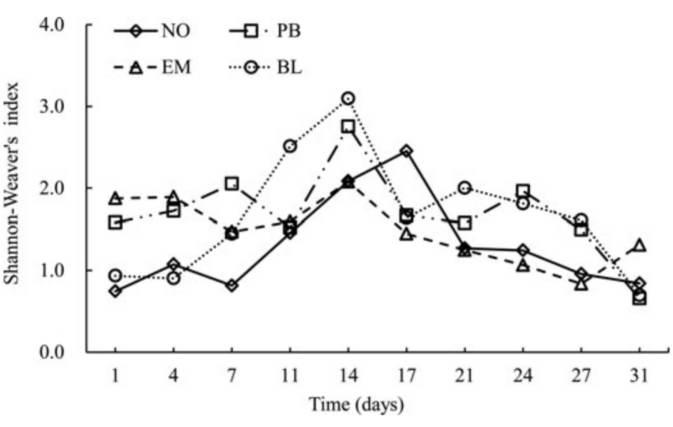


Figure 2. [illegible] (BL [illegible] -A [illegible] A (B), [illegible] (B [illegible]).

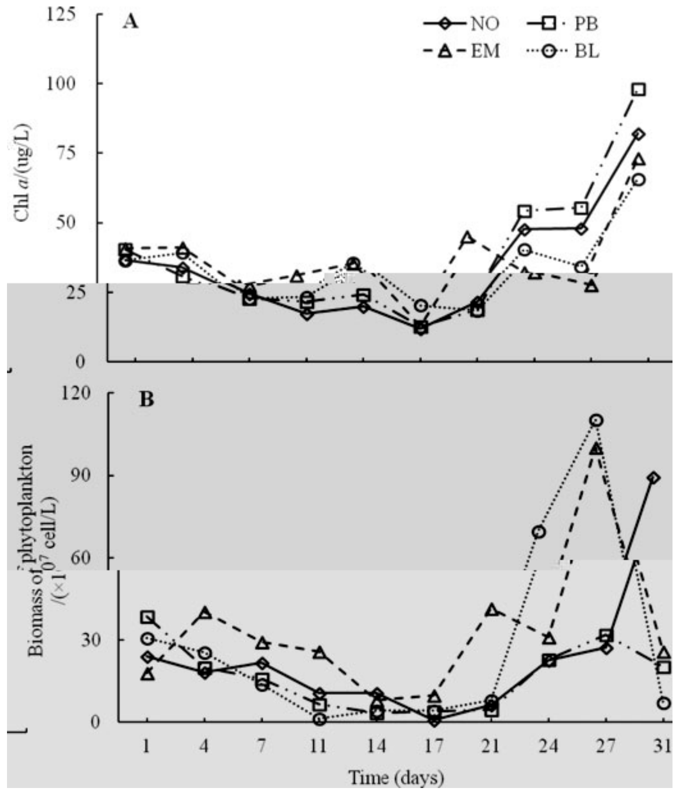
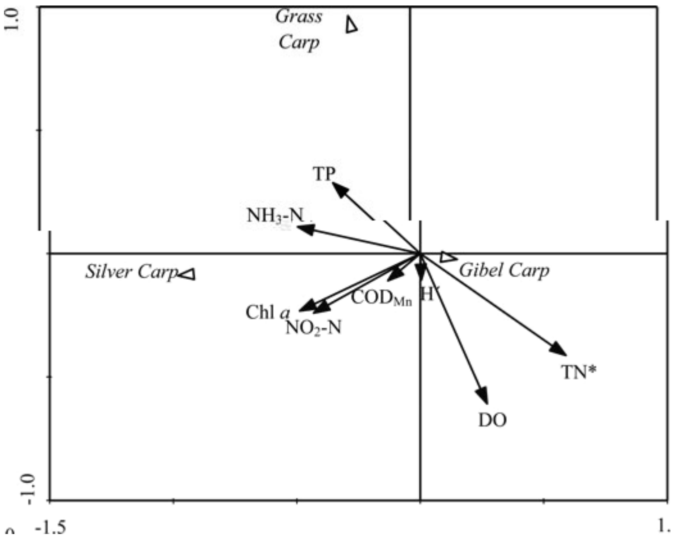


Figure 3. [illegible] **(A)** [illegible] *a* (Chl *a*) [illegible] **(B)** [illegible] (BL [illegible] -A [illegible] A (B), [illegible] (B [illegible]).

[illegible] (2008) [illegible] *Bacillus subtilis* [illegible] A [illegible] 2009) [illegible] ($^{2-}$ [illegible] $^{3-}$) [illegible] 2005; [illegible] 2012). [illegible] $^{2-}$ [illegible] 2009) [illegible] (B [illegible] 1984; [illegible] 2009). [illegible] $^{2-}$ [illegible] 2005) [illegible] 2008). [illegible]



4. … Chl *a* … *a*; … 3- … 2- … (*P* < 0.05).

… B … 2000). … (2009) …

h , ., 1949. h th t th

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h A A 71:315 319.

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B 64:655 671.

2004.
th h 28:568 572. (
h h)

B., 2008. h
A 281:1 4.

B., 2005. h
th h h *Penaeus vannamei* h
71:1036 1041.

A. 2010.
(*Oreochromis* .)