

Accepted Manuscript

Effect of dietary *Clostridium butyricum* on growth, intestine health status and resistance to ammonia stress in Pacific white shrimp *Litopenaeus vannamei*

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PII: S1050-4648(17)30174-2

DOI: [10.1016/j.fsi.2017.03.048](https://doi.org/10.1016/j.fsi.2017.03.048)

Reference: YFSIM 4517

To appear in: *Fish and Shellfish Immunology*

Received Date: 27 December 2016

Revised Date: 17 March 2017

Accepted Date: 26 March 2017

Please cite this article as: Duan Y, Zhang Y, Dong H, Wang Y, Zheng X, Zhang J, Effect of dietary *Clostridium butyricum* on growth, intestine health status and resistance to ammonia stress in Pacific white shrimp *Litopenaeus vannamei*, *Fish and Shellfish Immunology* (2017), doi: 10.1016/j.fsi.2017.03.048.

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1 **Effect of dietary *Clostridium butyricum* on growth, intestine health status and**
2 **resistance to ammonia stress in Pacific white shrimp *Litopenaeus vannamei***

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8 **ABSTRACT** The present study evaluated the effect of dietary *Clostridium butyricum* (CB) on growth,
9 intestine microstructure, intestine digestive and immune function, intestine short-chain fatty acids (SCFA)
10 content and body composition of Pacific white shrimp *Litopenaeus vannamei*. The shrimp was fed for 56 d
11 with diets containing different levels of *C. butyricum* (1×10^9 cfu/g): 0% (Control), 0.25% (CB1), 0.5%
12 (CB2) and 1.0% (CB3) as treatment groups, followed by an acute ammonia stress test for 72 h. The results
13 indicated that dietary supplementation of *C. butyricum* decreased the feed conversion rate (FCR) and
14 increased the growth performance of shrimp. Compared with the control group, after shrimp fed with *C.*
15 *butyricum* 56 d, intestine amylase and protease activity in the three *C. butyricum* group increased, while
16 lipase activity was only affected in the CB1 and CB2 group. Total antioxidant capacity (T-AOC) content,
17 lysozyme (LSZ) activity, and the relative expression level of Toll and immune deficiency (Imd) gene all
18 increased in three *C. butyricum* groups. Inducible nitric oxide synthase (iNOS) activity increased in the
19 CB2 and CB3 group, heat shock protein 70 (HSP70) gene expression level increased in the CB3 group,
20 while nitric oxide (NO) content was not affected by *C. butyricum*. After shrimp exposed to ammonia stress,
21 intestine immune biochemical parameters (T-AOC, LSZ, iNOS and NO) and genes (HSP70, Toll and Imd)
22 expression level of *C. butyricum* group was higher than that of the control. HE stain showed that *C.*
23 *butyricum* increased the intestine epithelium height of *L. vannamei*. These results revealed that *C.*
24 *butyricum* could improve the growth performance, increased intestine SCFA content and body crude
25 protein content, modulated intestine digestive capacity, and enhanced intestine immune function of *L.*
26 *vannamei* against ammonia stress.

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