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Effects of partial replacement of fish meal by yeast hydrolysate on complement system and stress resistance in juvenile Jian carp (*Cyprinus carpio* var. Jian)

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1 Effects of partial replacement of fish meal by yeast hydrolysate on
2 complement system and stress resistance in juvenile Jian carp (*Cyprinus*
3 *carpio* var. Jian)

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8 **ABSTRACT**

9 A 10-week feeding trial was carried out to investigate the effects of dietary fish meal
10 replacement by yeast hydrolysate (YH) on growth performance, complement system and stress
11 resistance of juvenile Jian carp (*Cyprinus carpio* var. Jian) (initial average weight 19.44±0.06 g).
12 In the study, there were five groups: one control group was fed with a basal diet (YH0), and four
13 treatment groups were fed with dietary fish meal replaced by 1% YH (YH1), 3% (YH3), 5% (YH5)
14 and 7% (YH7), respectively. Each group had four replicates. At the end of feeding trial, twelve
15 fish from each group (three fish per replicate) were randomly selected for assessing the growth
16 and immunity. Meanwhile, 20 fish per replicate were injected by *Aeromonas hydrophila*. The
17 results showed that (1) Replacement levels of YH significantly affected the growth of the fish with
18 the highest values of weight gain (WG) occurred in fish fed YH3 diet. However, no significant
19 difference in feed conversion ratios (FCR) was observed among all groups. (2) Pre-stressed
20 plasma lysozyme activity, total protein and albumin contents and complement component 3 (C3)
21 and complement component 4 (C4) levels of fish fed YH3 diet were significantly higher than
22 those of fish fed YH0 diet. However, post-stressed immune parameters of fish in all groups were
23 significantly lower. (3) There was a trend that the expression levels of the complement-related
24 genes (c1r/s-A, c4-1, c3-H1, c5-1, fb/c2-A, mbl-2 and masp) initially increased and then decreased
25 except mbl-2 and masp, with the maximum values observed in fish fed YH3 diet. Before stress,
26 the expression levels of the inflammation-related genes (alp, il-1β and tnf-α) in the hepatopancreas
27 and spleen of fish fed YH1 diet and YH7 diet were significant higher than that of fish fed YH0 diet.
28 After stress, no significant difference in the expression levels of those genes was observed among
29 all groups. These results indicated that FM replacement by YH could improve growth performance,
30 enhance innate immunity, and activate complement via the alternative complement pathway (ACP)
31 and the classical complement pathway (CCP).

32 **Keywords:** Yeast hydrolysate, Innate immunity, Complement system, Stress resistance, *Cyprinus*
33 *carpio* var. Jian

34 **1. Introduction**

35 Fish meal (FM), which is rich in digestible protein, calcium, phosphorus and essential fatty
36 acids, is regarded as a kind of indispensable dietary protein source for fish [1,2]. Traditionally, FM
37 that was widely used in aquafeeds mainly came from industrial and small pelagic species such as

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