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# Effects of fulvic acid on growth performance and intestinal health of juvenile loach *Paramisgurnus dabryanus* (Sauvage)

Author links open overlay panel [Yang Gao<sup>a1</sup>](#) [Jie He<sup>b1</sup>](#) [Zhuliu He<sup>a</sup>](#) [Zhiwei Li<sup>a</sup>](#) [Bo Zhao<sup>a</sup>](#) [Yimu Jeong<sup>-</sup>](#) [Yeol Lee<sup>c</sup>](#) [Zhangjie Chu<sup>a</sup>](#)

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## Highlights

- Fulvic acid improved growth performance of *P. dabryanus*.
- Fulvic acid improved intestinal antioxidant ability and immunity of *P. dabryanus*.
- Fulvic acid changed intestinal **microflora** composition of *P. dabryanus*.
- Fulvic acid could be used as substitute for antibiotic treatment.

## Abstract

A 60-day feeding trial was conducted to determine the effect of dietary **fulvic acid** supplements on intestinal digestive **activity** (**enzymatic analysis**), **antioxidant activity**, immune **enzyme activity** and **microflora** composition of **juvenile loach** (initial **weight** of  $6.2 \pm 0.1$  g) reared in experimental **aquaria**. Five test **diets** containing 0, 0.5, 1.0, 1.5, and 2% fulvic acid were randomly assigned to three aquaria, respectively. Elevated **growth performance** including final **weight**, **weight gain** (WG), **specific growth rate** (SGR) and **feed conversion ratio** (FCR) was observed in loaches that were **fed** fulvic acid. Maximal weight gain rates and specific **growth** rates occurred at the 1.5% additive level. The optimal dietary fulvic requirement for maximal growth of juvenile loach is 16.4 g per kg of the **diet** based on the quadratic **regression analysis** of specific **growth rate** against dietary

fulvic acid levels. Furthermore, intestinal **protease** activity, **antioxidant activity**, **lysozyme** activity (LZM), **complement 3 (C3)** content, **immunoglobulin M (IgM)** content, **acid phosphatase** activity (ACP) and **alkaline phosphatase** activity (AKP) were significantly elevated with concomitant increasing levels of dietary fulvic acid. Following a **deep sequencing** analysis, a total of 42,058 valid reads and 609 OTUs (operational taxonomic units) obtained from the control group and the group displaying the most optimal growth rate were analyzed. Fulvic acid **supplementation** resulted in an abundance of *Firmicute* and **Actinobacteria** sequences, with a concomitant **reduction** in the abundance of **Proteobacteria**. Results indicated that fulvic acid supplementation resulted in a reduction in the relative abundance of **Serratia**, **Acinetobacter**, **Aeromonas** and **Edwardsiella**, and a relative increase in the abundance of **Lactobacillus** in the **intestine**. In conclusion, these results suggest that fulvic acid improves growth performance and intestinal health condition of loach, indicates that fulvic acid could be used as an immunoenhancer in loach culture.