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Intestinal immune responses of Jian carp against *Aeromonas hydrophila* depressed by choline deficiency: Varied change patterns of mRNA levels of cytokines, tight junction proteins and related signaling molecules among three intestinal segments

Pei Wu, Yang Liu, Wei-Dan Jiang, Jun Jiang, Yong-An Zhang, Xiao-Qiu Zhou, Lin Feng

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Intestinal immune responses of Jian carp against Aeromonas hydrophila 1 depressed by choline deficiency: varied change patterns of mRNA levels of 2 3 cytokines, tight junction proteins and related signaling molecules among three intestinal segments 4 5 Pei Wu ^{1,2,3}, Yang Liu ^{1,2,3}, Wei-Dan Jiang ^{1,2,3}, Jun Jiang ^{2,3}, Yong-An Zhang ⁴, 6 Xiao-Qiu Zhou 1,2,3 *, Lin Feng 1,2,3 * 7 8 9 ¹Animal Nutrition Institute, Sichuan Agricultural University, Chengdu, 611130, China 10 ²Fish Nutrition and Safety Production University Key Laboratory of Sichuan Province, 11 12 Sichuan Agricultural University, Chengdu, 611130, China ³Key Laboratory for Animal Disease-Resistance Nutrition of China Ministry of 13 Education, Sichuan Agricultural University, Chengdu, 611130, China 14 ⁴Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan 430072, China 15 16 Running title: Choline ameliorated intestinal inflammation of fish 17 18 * Corresponding authors. Tel.: +86-835-2885157; Fax: +86-835-2885968. 19 E-mail address: zhouxq@sicau.edu.cn (X.-Q. Zhou); fenglin@sicau.edu.cn (L. Feng). 20 21

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