Original Article

Effects of dietary conjugated linoleic acids on the growth and quality of large yellow croaker fish *Pseudosciaena crocea* (Richardson) in cages

Weiguo Sang MAppSci, Xiaoxi Wei BS and Huihui Wu MS

Faculty of Life Science and Biotechnology, Ningbo University, Ningbo, China

The objective of this study was to investigate the effect of conjugated linoleic acids (CLA) in artificial feeds on the growth and quality of large yellow croaker (*Pseudosciaena crocea)* raised in cages. Two diet formulas with dietary CLA were developed, and a diet without of CLA served as a control. The effects of CLA (2% and 4%) on average daily gain per tail (DGT), feed conversion ratio (FCR), muscle lipid, and lean body mass (LBM) for a 60-day period were evaluated. The results from two independent experiments revealed that diets with 4% CLA significantly improved DGT and FCR ($p<0.05$). Muscle lipid significantly reduced as increase of CLA content in diets ($p<0.01$), correspondingly, the LBM significantly increased ($p<0.05$). This study demonstrates that CLA supplemental diet could be used to improve growth and quality of large yellow croaker raised in cages.

Key Words: conjugated linoleic acids, large yellow croaker, fish, daily gain, feed conversion ratio, lean body mass

Introduction

Large yellow croaker *Pseudosciaena crocea* (Richardson) was one of the four major marine products in China before the middle of 1970s. The resource of large yellow croaker was almost destroyed because of being over harvested. The technology for producing large yellow croaker in cages was introduced in 1990s and currently used commercially around the country. However, large yellow croaker raised in cages has high body lipid and poor muscle texture. Therefore, there is a need to improve the quality of large yellow croaker from cages; one approach is to enhance the fish diets with CLA.

CLA comprises a mixture of positional and geometric isomers of octadecadienoic fatty acid with conjugated double bonds. These conjugated dienes were found to be responsible for many biological properties that relate to health.[1, 2] Dietary CLA were shown to alter growth responses and tissue composition of various terrestrial animals and improve feed efficiency (FE) in rats and in rainbow trout juveniles.[2-6] Recent studies indicated that dietary 10trans, 12cis-conjugated linoleic acids (10t, 12c-CLA) may alter fatty acid metabolism in salmon,[7] and can reduce body fat by 25% in mice.[5]

Dietary conjugated linoleic acids (CLA) have been shown to alter growth rates and tissue lipid concentrations in some species of fish, such as channel catfish,[8] common carp, Nile tilapia and rockfish.[9] However, the effect of dietary CLA on the growth response of large yellow croaker has not been reported, and little information is available for CLA supplement diets used for large yellow croaker. In the current study, CLA supplement diets for large yellow croaker were developed and the growth rate and quality of fish fed with these diets were evaluated.

Materials and methods

Diet

All diets were formulated to contain 45% (w/w) crude protein to maintain a constant energy level. Diet A and Diet B contained additional 2% and 4% dietary 10t, 12c-CLA, respectively. A diet without CLA served as a control. Table 1 shows the main compositions and formulas of three diets. Dry ingredients were thoroughly mixed with water, lipid and CLA in a twin-screw extruder and formed into 4-mm pellets. The pellets were dried in a forced-air oven and stored at -18℃ until use.

Fish

Large yellow croaker was obtained from local farms and each fish weighted in the range of 52 to 55 g. The experiments were conducted in two farms independently. In each farm, 27 fishes were evenly blocked into 3 cages. Temperature, pH, and salinity of water were maintained at 25±2ºC, 7.6±0.2, and 27±3‰, respectively. The fish was fed twice daily at 5:30 am and 5:30 pm for 60 days. The quantity of feed was so controlled that the feed could be completely consumed by fishes in 5 min.

Corresponding Author: Associate Professor Weiguo Sang, Faculty of Life Science and Biotechnology, Ningbo University, Post Box#66, Fenghua Rood#818, Ningbo, China 315211
Tel: 86 574 87600155; Fax: 86 574 87600551
Email: sangweiguo@nbu.edu.cn

Table 1. Main nutritional elements and contents of formula diets for large yellow croaker

Main nutritional element	Control	Diet A	Diet B
Protein / %(w/w)	45.8	45.7	45.2
Lipid / %(w/w)	5.7	5.6	5.8
CLA(trans-10,cis-12) / %(w/w)	0	2	4
Water / %(w/w)	9.1	9.3	9.6

Table 2. Effect of CLA diets on growth of large yellow croaker[1,2]

Cage No.	Diet	TSW (kg)	TEW (kg)	TDW (kg)	TF (kg)	DGT ($g \cdot d^{-1} \cdot tail^{-1}$)	FCR
1	Control	0.47±0.10[a]	0.87±0.10[a]	0.09±0.03[a]	1.25±0.05[a]	0.90±0.11[a]	2.56±0.11[a]
2	A	0.47±0.10[a]	1.03±0.11[a]	0.08±0.03[a]	1.25±0.05[a]	1.19±0.15[a]	1.95±0.07[a]
3	B	0.47±0.10[a]	1.15±0.10[a]	0.08±0.04[a]	1.25±0.05[a]	1.41±0.17[b]	1.64±0.11[b]
4	Control	0.50±0.10[a]	0.88±0.11[a]	0.11±0.03[a]	1.25±0.05[a]	0.91±0.09[a]	2.54±0.06[a]
5	A	0.50±0.10[a]	1.16±0.10[a]	0.09±0.04[a]	1.25±0.05[a]	1.40±0.14[b]	1.65±0.13[b]
6	B	0.50±0.10[a]	1.28±0.10[a]	0.09±0.04[a]	1.25±0.05[a]	1.62±0.08[b]	1.43±0.09[b]

[1] Values are expressed as means ± standard deviations of 5 measurements. Means with the same letter in the same column are not significantly different (p <0.05). [2] TSW = total start weight of fish; TEW = total end weight; TDW = total dead fish weight; TF = total feed weight for feeding; DGT = average daily gain per tail; FCR = feed conversion ratio.

Table 3. Effect of CLA diets on lipid content and lean body mass of large yellow croaker[1]

Cage No.	Diet	Lipid (%, w/w)	Lean body mass (kg)
1	Control	4.25±0.04[a*]	0.90±0.11[a]
2	A	2.35±0.02[b*]	1.19±0.15[a]
3	B	2.18±0.03[b*]	1.41±0.17[b]
4	Control	4.61±0.05[a*]	0.91±0.09[a]
5	A	2.27±0.04[b*]	1.40±0.14[b]
6	B	2.15±0.05[b*]	1.62±0.08[b]

[1] Values are expressed as means ± standard deviations of 5 measurements. Means with the same letter in the same column are not significantly different (p<0.05); Means with the same letter with a * in the same column are not significantly different (p<0.01).

Statistical analysis

A completely randomized and factorial design was used for this experiment. All data points are presented by the mean with standard deviation (n=5). Data sets were analyzed by student t-test using SPSS11.5 (SPSS, Inc. Chicago, IL) and EXCEL, version7.0 for the multiple means comparisons. Significance of difference was reported at $p < 0.05$ or $p < 0.01$.

Results

Effect of dietary CLA on growth of large yellow croaker

Average daily weight gain per tail (DGT) and feed conversion ratio (FCR) of fishes fed with dietary CLA were significantly improved (p <0.05) as showed in Table 2. Increase of CLA content in diet results in an increase of DGT and a decrease of FCR.

Effect of dietary CLA on quality of large yellow croaker

Table 3 shows that quality of large yellow croaker, in terms of muscle lipid and lean body mass, was significantly improved when fish fed with dietary CLA. Muscle lipid from 4.25/4.61 reduced to 2.35/2.27 for 2% CLA diets and further reduced to 2.18/2.15 for 4% CLA diets. Correspondingly, lean body mass increased from 0.90/0.91 to 1.19/1.40 for 2% CLA diets and further increased to 1.41/1.62 for 4% CLA diets.

Discussion

The effects of conjugated linoleic acid (CLA) on body composition were investigated extensively. Mice fed CLA-supplemented diet exhibited 60% lower body fat and 14% increased lean body mass relative to controls.[2,8] The effects of CLA on body composition appear to be due in part to reduced fat deposition and increased lipolysis in adipocytes, possibly coupled with enhanced fatty acid oxidation in both muscle cells and adipocytes.[9,10] Other results indicated that 18:2(trans-10,cis-12), and not 18:2(cis-9,trans-11), is the bioactive isomer of fat-metabolizing.[1,10,11] In the current study, better growth of large yellow croaker was observed and better quality of fish muscle was obtained when fish fed with dietary CLA. Our results suggest that large yellow croaker has similar biological response to CLA as other animals. This study demonstrates that dietary CLA could improve productivity and quality of large yellow croaker raised in cages.

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