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Long-term effects of dietary cottonseed meal on growth and reproductive performance of rainbow trout: Three-year study

Kyeong-Jun Lee [a,1], Jacques Rinchard [a], Konrad Dabrowski [a,*], Igor Babiak [a,b,2], Joseph S. Ottobre [c], James E. Christensen [a]

[a] *School of Natural Resources, The Ohio State University, Columbus, OH 43210, USA*
[b] *Department of Animal Biochemistry, University of Warmia and Mazury in Olsztyn, 10-718 Olsztyn, Poland*
[c] *Department of Animal Sciences, The Ohio State University, Columbus, OH 43210, USA*

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Abstract

A long-term feeding experiment (35 months) was conducted to study the effects of substitution of fish meal (FM) by cottonseed meal (CM) on growth, feed utilization and reproductive physiology in rainbow trout (*Oncorhynchus mykiss*). Five groups of fish (1.5 years old; 246 ± 10 g) were fed one of five experimental diets formulated to substitute FM with CM (147, 294, 441 and 588 g/kg designated as diets CM0, CM25, CM50, CM75 and CM100, respectively, based on percentage of protein replacement). The results showed that dietary CM significantly affected the coefficient of total apparent digestibility (CTTAD) of protein and phosphorus. However, in the long-term, it did not impact fish growth. Growth rates within male and female groups were not significantly affected by the dietary CM replacement after the 3 years of feeding. Gossypol-related mortality was not found in the fish during the 3 years of feeding. Muscle gossypol concentrations after 3 years were significantly different among groups and corresponded to the dietary concentration. Less than 1.0 μg

* Corresponding author. Tel.: +1 614 292 4555; fax: +1 614 292 7432.
E-mail address: dabrowski.1@osu.edu (K. Dabrowski).
[1] Present address: Faculty of Applied Marine Science, Cheju National University, Cheju 690-756, South Korea.
[2] Present address: Department of Fisheries and Natural Sciences, Bode Regional University, 8049 Bode, Norway.

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gossypol/g wet basis of muscle was found in the highest dietary CM group. In males, the concentration of steroid hormones and the reproductive performances including sperm concentration, motility and eyed-stage embryo survival in the third year of this study were not significantly affected by the dietary CM inclusion. In contrast, female rainbow trout fertility and plasma testosterone levels were negatively affected by complete replacement of FM protein with CM protein. The findings based on this long-term study suggest that high dietary CM supplementation up to 58.8/100 g or complete substitution of FM protein does not impair growth of both sexes and reproductive performance of male rainbow trout, and that humans can safely consume the fillet produced by fish fed CM-containing diets.

Keywords: Rainbow trout; Cottonseed meal; Fish meal; Growth; Gossypol; Reproduction

1. Introduction

Cottonseed meal (CM) is the third largest oil-seed meal product in world production after soybean and rapeseed meal (USDA, 2000). In the USA, CM is the second largest plant protein source after soybean meal, with the cotton industry being an important part of US agriculture over the past two centuries. As the processing technology has been improved and innovated, the use of cottonseed has expanded as a food and feed supplement. Therefore, CM has been extensively studied as a protein source for feed in ruminants (Chan et al., 1998; Nagalakshmi et al., 2001) and non-ruminant animals (Gamboa et al., 2001; Henry et al., 2001) including fish (Herman, 1970; Robinson and Tiersch, 1995; Cheng and Hardy, 2002). However, gossypol is the main constraint to limit the use of cottonseed for animals and humans. Gossypol is a naturally occurring polyphenolic dialdehyde present in cotton plants, *Gossipium* sp., especially in its pigment glands. To increase the use of cottonseed products in animal feeds, the gossypol toxicity imposed on nutritional and reproductive events has been extensively studied and reported (Velasquez-Pereira et al., 2002) and preventive measures have been sought.

The deleterious effects of gossypol and the use of CM in feeds on nutritional and reproductive performance during several reproductive cycles in salmonid have not been studied until now, unlike in ruminants or non-ruminant terrestrial animals. Furthermore, a lack of consistency in the results of a few studies in fish was noticeable due to the variation in fish size and species and duration of CM feeding with or without supplementation of lysine that is a limiting amino acid in the presence of gossypol (Henry et al., 2001).

A series of studies was conducted on the utilization of CM and toxicity of gossypol to fish (Mbahinzireki et al., 2001; Dabrowski et al., 2000, 2001; Blom et al., 2001; Lee et al., 2002; Lee and Dabrowski, 2002; Rinchard et al., 2002, 2003). In the present paper, new data are provided and results of a long-term (35 months) experiment on the effect of CM on growth rate, apparent digestibility coefficient of protein and absorption of phosphorus, hemoglobin and hematocrit levels, plasma concentrations of steroid hormones and reproductive events in male and female rainbow trout, *Oncorhynchus mykiss* are presented.