

The Effects of Dietary Levels of Copper and Zinc on Rate and Efficiency of Growth by Rainbow Trout

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Abstract

The objectives of this factorial experiment were to determine if interactions existed between dietary Cu and Zn levels on rate and efficiency of growth and whole body element retention in growing trout. After 6 wks of feeding a diet deficient in Cu (9.4 ppm) and Zn (37.7 ppm), 600 fish (avg wt of 40 g) were randomly assigned to diets with supplementary CuSO₄ or ZnSO₄ added to provide diets with 0 or 10 ppm added Cu and 0, 30, 300 or 1500 ppm added Zn. There were 25 fish per tank with 3 replications per diet. Diets were formulated to contain 40% CP from soybean meal and corn protein concentrate and 20% crude lipid. Fish were fed experimental diets for 12 wks. The main effects of dietary Cu level, Zn level and the potential interaction on growth and mineral retention were tested. After 6 and 12 wks, 3-5 fish from each tank were sacrificed to determine liver and whole body concentrations of Cu and Zn. Cataracts were observed at 12 wks in 69% of fish fed the Cu and Zn deficient diet compared to an average of .01% for all other treatments. Dietary Zn (P=0.002) but not dietary Cu (P=0.263) increased 12 wk weight gain. An interaction (P=0.008) between dietary Cu and Zn was observed for 12 wk weight gain. Slowest gains (19 g/d) were for the Cu and Zn deficient diet and fastest gains (45 g/d) were in the 10 ppm Cu and 1500 ppm Zn diet. Dietary Zn (P=0.001) but not dietary Cu (P=0.996) increased 12 wk whole body Zn levels. Dietary Cu (P=0.094) or Zn (P=0.095) did not alter whole body Cu levels and no interactions were observed (P=0.806).

Introduction

Previous research has addressed interactions between Cu and Zn (Skoryna (1971) and Ammerman (2003). Further support of an antagonistic relationship between Cu and Zn, is the review reported by Ammerman et al (2003), who described several studies in a wide range of species including rats, chicks, pigs and sheep, where detrimental effects of Cu status were seen due to excess dietary Zn levels. Although less studied, interactions between Cu and Zn in rainbow trout have been previously investigated. Knox et al., (1984) found liver Cu levels reduced when excess Zn was provided in a purified diet. In contrast, Gatlin et al., (1988) found no effect of high levels of dietary Zn on Cu liver stores.

This study was designed to determine the effects of increasing Zn levels on Cu uptake and rate and efficiency of growth of trout.

Objective

To determine if interactions existed between Cu and Zn on rate and efficiency of gain and Cu tissue levels in rainbow trout when provided:

- *Increasing levels of dietary Zn (0, 30, 300, 1500 ppm)
- *Two levels of dietary Cu (0 & 10 ppm)

Methods

- 2x4 factorial design
- Tank= Experimental Unit
- 25 fish/ tank
- 3 replicates per treatment
- 6wk depuration period prior to start of study
- Fish fed to visual satiation 2 x a day, 6 days per week
- Tank weights measured every 3 wks
- At 6-12 wks, 3-5 fish from each tank removed for whole body samples
- Use of ICP to determine Cu and Zn whole body levels

Results

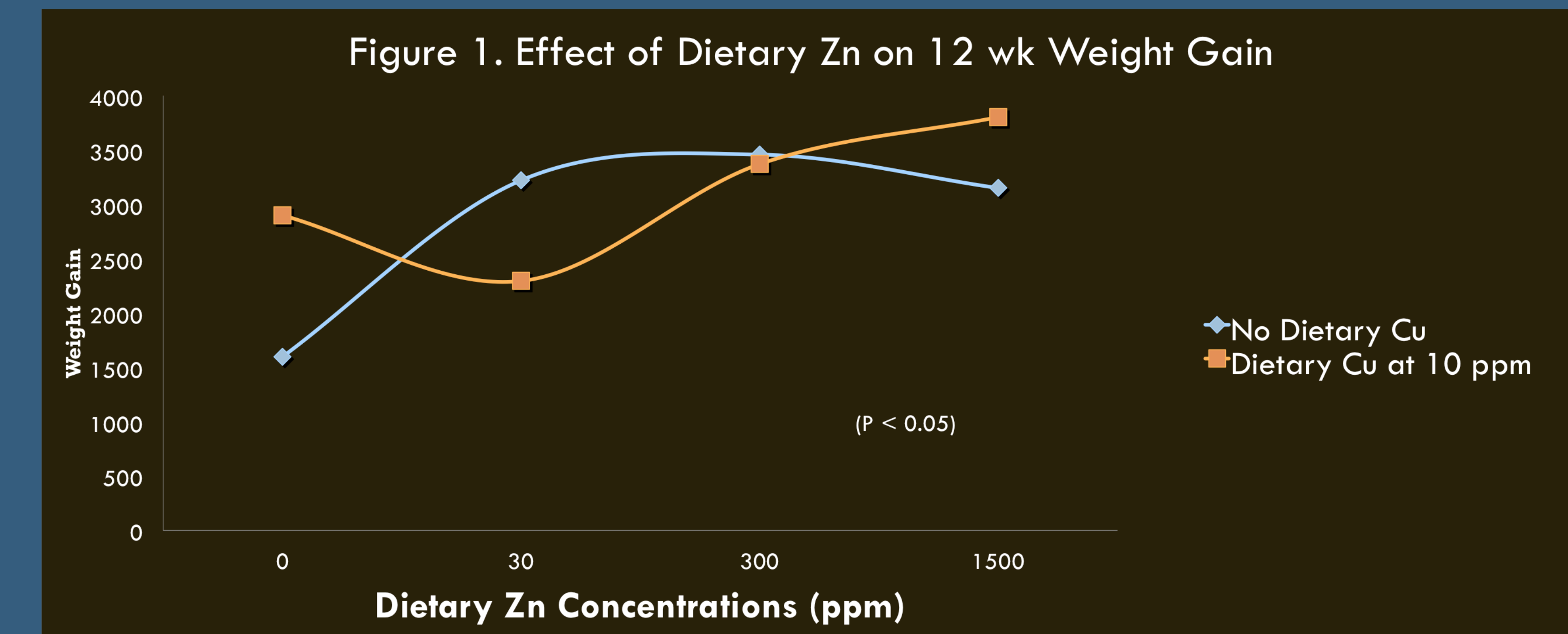
•FCR and feed intakes were higher (P<0.05) in trout fed the Cu and Zn deficient diet and the Cu 0 ppm and Zn 30 ppm diet.

•At 12 wks, highest (P<0.05) weight gain was in trout fed 10 ppm Cu and dietary Zn at 300 and 1500 ppm (Figure 1).

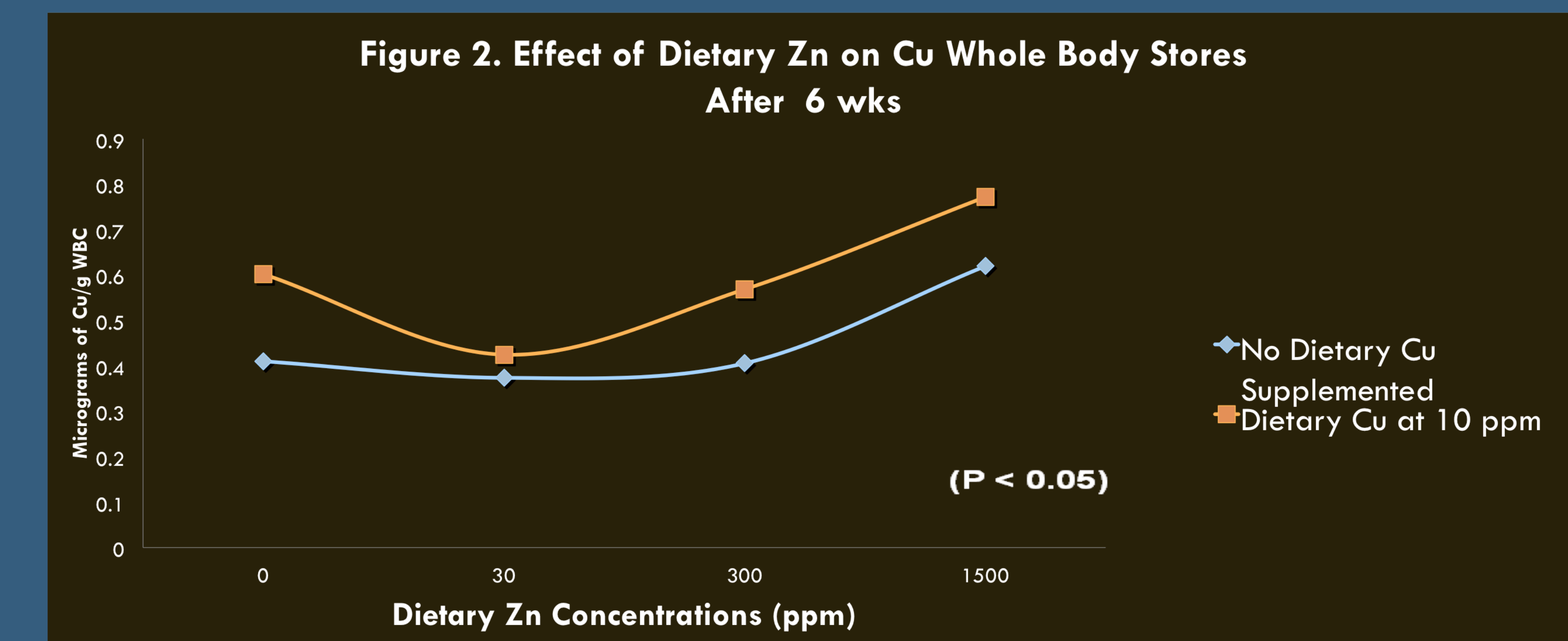
•Whole body Cu levels at 6 wks were highest (P<0.05) in diets supplemented with 10 ppm Cu and Zn at 1500 ppm (Figure 2).

•At 6 & 12 wks increasing Zn supplementation increased (P< 0.05) Zn whole body levels.

•At 12 wks, grossly visible signs of cataracts & tail rot were observed in trout fed Cu and Zn deficient diet.



Highest (P<0.05) weight gains in trout fed 300 & 1500 ppm dietary Zn at 12 wks.



Cu whole body stores at 6 wks were highest (P<0.05) when dietary Zn was supplemented at 1500 ppm.

Implications

Results of this study show rainbow trout fed plant-based diets require Zn supplementation to obtain sufficient growth. Level of supplemented Cu did not improve weight gain. However, the level of Zn did improve weight gain, at the higher dietary levels (300 and 1500 ppm)

The highest levels of Zn supplementation did not impair Cu uptake. Diets without supplemental Cu or Zn caused an increased incidence of cataracts.