

**EFFECTS OF STEROIDS AND THEIR ANTAGONISTS ON THE  
CARDIAC PERFORMANCE OF RAINBOW TROUT  
(*ONCORYNCHUS MYKISS*)**

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**EXTENDED ABSTRACT ONLY- DO NOT CITE**

Positive effects of steroid hormones and their antagonists on cardiac tissue in mammals are well known. For example, Valencia *et al.* (1989) demonstrated positive inotropism in rat atrium after addition of testosterone and dihydrotestosterone; this effect was blocked by antiandrogens. However, the acute effects of steroids in teleost cardiac tissue have not been studied. The goal of this research was to investigate the effects of steroids on contractile performance of cardiac tissue from rainbow trout. We also tested whether steroid effects involve activation of transcription or protein synthesis.

**Experimental Animals**

Immature male and female ( $251 \pm 9$  g;  $27.2 \pm 3.4$  cm) and sexually mature male ( $1216 \pm 348$  g;  $44.2 \pm 4.2$  cm) rainbow trout were obtained from Clear Springs Foods, Inc. (Buhl, Idaho).

**Ventricle strip preparation**

Fish ( $n = 6$  for each treatment) were killed by a sharp blow to the head, the ventricle was excised and placed in ice-cold teleost Ringers solution (pH 7.6). Four uniform strips were cut from each ventricle (dry weight =  $1.5 \pm 0.5$  mg).

Each strip was tied with surgical silk and attached to a Kent isometric transducer, bathed in Ringers at 14°C, and gassed with 99.5% O<sub>2</sub> / 0.5% CO<sub>2</sub> in tissue baths. Strips were stimulated to contract with maximum voltage (60V) at 0.5 Hz and the length of each strip was adjusted to produce maximal twitch force. After equilibration for 1 h, physiological levels of androgens (T, 11KT) and cortisol dissolved in ethanol were administered and recordings were taken continuously for 30 min. Pre-treatment (10 min) with flutamide and RU486, (inhibitors of androgen and cortisol receptors, respectively) were used to determine if steroid effects involved specific receptors. In addition, cycloheximide or actinomycin D were used to determine whether steroid effects were non-genomic. Cholesterol was used to ensure that cardiac performance did not improve with general steroid administration. Twitch force development was measured using the Biopac MP100 system and Acknowledge software. Changes in twitch force development were normalized (%) based on initial equilibration.

### **Data analysis**

Differences between control and steroid treated strips were assessed by ANOVA ( $p < 0.05$ ).

### **Results**

Both androgens (T, 11KT) increased contractile force 40% within 10 min in strips from male rainbow trout. However, this effect was not seen in female rainbow trout. In males, flutamide effectively blocked the increases induced by T and 11KT (Figure 1A). Cortisol increased contractile force in both males (40%) and females (20%) within a similar time. RU486 blocked cortisol effects in both males and females (Figure 1B). The optimal concentration for increasing contractile force was 0.03 $\mu$ M for the sex hormones and 0.01mM cortisol.

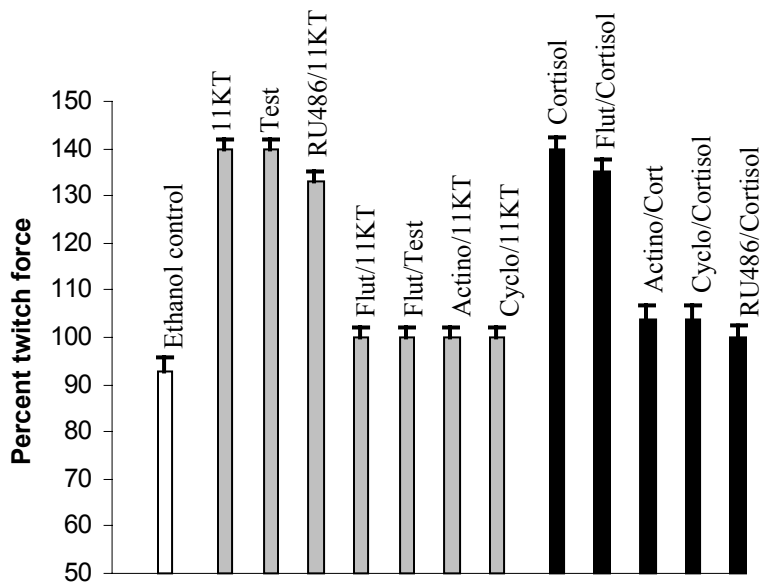


Fig. 1A. Percent of original twitch force (+SE) in ventricle strips from **male rainbow trout** after exposure to steroids and steroid antagonists (n = 6 for each treatment). 11-ketotestosterone (11KT), Testosterone (Test), Flutamide (Flut), Actinomycin (Actino), Cycloheximide (Cyclo).

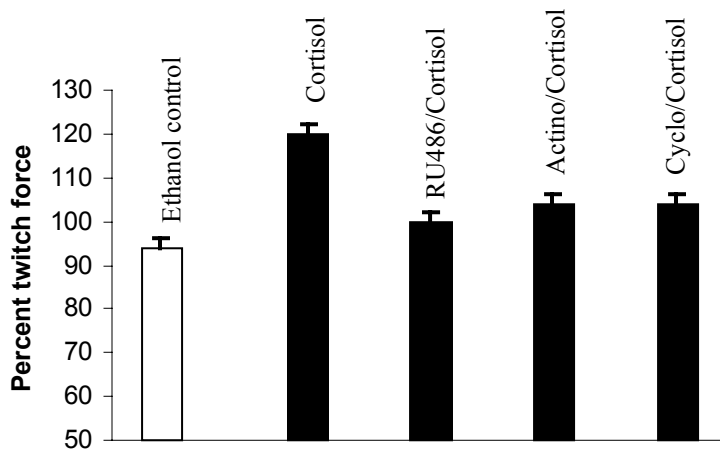


Fig. 1B. Percent of original twitch force in ventricle strips from **female rainbow trout** after exposure to cortisol and steroid antagonists (n = 6 for each treatment). 11KT or T strips were not significantly different from ethanol control. Actinomycin (Actino), Cycloheximide (Cyclo).

However, flutamide had no effects on cortisol treated strips, and RU486 did not affect T or 11KT treated strips. Actinomycin D or cycloheximide almost completely inhibited the increased twitch force observed after treatment with T, 11KT or cortisol. Cholesterol had no effects on contractile performance.

These results demonstrate that physiological concentrations of specific steroids can enhance ventricular contractility in rainbow trout. In males, testosterone, 11KT, and cortisol each act through their own receptors and may involve transcription and translation. Cortisol had similar effects in females. Although effects are realized within 10 min, it appears that the improved inotropism may involve transcription or protein synthesis. Ultimately, steroid mediated improvements in cardiac performance might enhance swimming activity during migration, spawning or other stressful periods.

### **Reference**

Garcia Valencia V., Andres-Trelles F., and Hidalgo A. 1989. Effects of 5-alpha and 5-beta-dihydrotestosterone on the left atrium of the rat *in vitro*. Rev. Clin. Exp. Pharmacol. **6**: 15-21

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