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Negative effect of 17-beta-estradiol on growth parameters of goldfish (*Carassius auratus*)

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PEER REVIEW

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Comments

This is a valuable research indicate with increase in the length and weight, the effects of the hormone get more distinct, so that with increase concentration of hormone, reduce weight and length. E2 along with testosterone and progesterone regulates final stages of oocyte maturation and ovulation. Various studies have proven the different concentrations of this hormone has different effects on the growth of different fishes. The aim of this study was to assess the effects of this hormone on growth factors of goldfish (*C. auratus*).
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ABSTRACT

Objective: To evaluate the effects of 17-beta-estradiol on growth factors of goldfish (*Carassius auratus*).

Methods: To perform the test, 17-beta-estradiol was given 3 months period to fish at different doses as followed: control group, Group 1: 10 mg/kg food, Group 2: 25 mg/kg food and Group 3: 50 mg/kg food. For this purpose, a solution of hormone in pure ethanol used to spray on food. Feeding was done 3 times daily as an appetite. Comparing the mean values measured for length and weight using ANOVA.

Results: Indicated with increase length and weight, the effects of the hormone get more distinct, so that with increase concentration of hormone, reduce weight and length.

Conclusions: Estradiol along with testosterone and progesterone regulates final stages of oocyte maturation and ovulation. Various studies have proven the different concentrations of this hormone has different effects on the growth of different fishes.

KEYWORDS

17-Beta-estradiol, Estrogen, *Carassius auratus*, Growth factors

1. Introduction

Goldfish from carp family (Cyprinidae) is a benthopelagic freshwater fish. Distributed in Central Asia, China and Japan and introduced throughout the world and several countries, however, its adverse ecological impact after introduction has been reported[1,2]. Goldfish inhabits in rivers, lakes, ponds and ditches

with stagnant or slow-flowing water[3]. This species was widely used in studies on reproductive and hormonal control[4].

17-Beta-estradiol is a natural estrogen. It has been shown to be a useful feminization hormone in some fishes[4], it produced by follicle cells in fish ovary persuade vitellogenesis gene copy and translation by liver cells and circulates through the bloodstream, finally ovum take it through intracellular receptors[5,6].

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Typically, vitellogenin is undetectable in immature males and females, whereas can be produced by external estrogen and estrogenic compounds[7].

One of the purposes of the hormonal induction order to sex change is to acquire a 100% growth potential. Some synthetic steroids certainly have effects to increase in growth[1]. In theory, increasing growth can occur by improving the appetite, digestion and absorption of various substances that any of these factors can be achieved by various steroids[8]. Estradiol increases the growth of yellow perch (*Perca flavescens*) through stimulating the appetite[9]. On the other hand, estradiol certainly leads to growth reduction in many fish species[8,10].

This research was conducted to investigate the effect of dietary estradiol on growth factors in goldfish [*Carassius auratus* (*C. auratus*)] like lengths and weights.

2. Materials and methods

For the experiment, a pair of goldfish were injected with pituitary gland hormone in dorsal fin and spawned. Larvae after initial adaptation with concentrate diet were evaluated biometrically (range 0.05-0.15 g and 0.22-0.27 cm) and randomly 30 larvae were introduced in each tank. There were 4 groups (Group 1: control group; Group 2: 10 mg/kg food; Group 3: 25 mg/kg food and Group 4: 50 mg/kg food) with 3 replication for them. Each of these tanks was filled with about 300 L of water. Continuous aeration was provided to supply the fish oxygen needing.

In this test, the fish was given 17-beta-estradiol for 3 months at different doses as follows: Group 1 was control group, Group 2 was treated with 17-beta-estradiol 10 mg/kg food, Group 3 was treated with 17-beta-estradiol 25 mg/kg food and Group 4 was treated with 17-beta-estradiol 50 mg/kg food. A solution of hormone in pure ethanol was sprayed on food[11]. Feeding was done 3 times daily as an appetite. For each group, three replicates were considered.

Fish bioassays were conducted once a month. Water quality parameters such as temperature, dissolved oxygen and pH were measured permanently and were as follows: temperature 19-29 °C, dissolved oxygen 5.5-7.0 mg/L, pH was fluctuating about 8.0-8.5.

3. Results

To investigate the mean of the measured values of the fish length, mean comparison test was done and the results are shown in Table 1. According to this table, there was no significant difference between length averages of fish in 4 groups in March,

but in the next two months were significantly different so that there was a significant difference between Group 1 with Groups 3 and 4 in April, as well as significantly different between Group 2 with Group 4. In May, Group 1 had a significant difference with all groups, as well as Groups 2 and 3 were significantly different with Group 4 but there were no significant difference between Groups 2 and 3.

Table 1

Comparison of average length changes in the different groups treated with different dose of 17-beta-estradiol during the three months (cm).

Groups	Average length		
	March	April	May
Group 1 (control)	0.24 ^a ±0.03	0.81 ^a ±0.13	1.81 ^a ±0.18
Group 2 (10 mg/kg food)	0.24 ^a ±0.02	0.80 ^{ab} ±0.14	1.66 ^b ±0.17
Group 3 (25 mg/kg food)	0.24 ^a ±0.02	0.77 ^{bc} ±0.09	1.65 ^b ±0.13
Group 4 (50 mg/kg food)	0.24 ^a ±0.04	0.75 ^c ±0.11	1.51 ^c ±0.14

Same letters indicate no differences among groups ($P < 0.05$, One-way ANOVA).

According to Table 2, there was no significant difference between the weights of the different groups in March. Also there was no significant difference in April, but in May Group 1 had a significant difference with all the groups and also about Group 2 with Group 4, but there were not significant differences between Groups 2 and 3.

Table 2

Comparison of average weight changes in the different groups treated with different dose of 17-beta-estradiol during the three months (g).

Groups	Average weight		
	March	April	May
Group 1 (control)	0.11 ^a ±0.02	0.27 ^a ±0.05	1.07 ^a ±0.13
Group 2 (10 mg/kg food)	0.11 ^a ±0.02	0.25 ^a ±0.04	1.01 ^b ±0.06
Group 3 (25 mg/kg food)	0.11 ^a ±0.02	0.23 ^a ±0.06	0.99 ^{bc} ±0.11
Group 4 (50 mg/kg food)	0.11 ^a ±0.03	0.22 ^a ±0.03	0.98 ^c ±0.08

Same letters indicate no differences among groups ($P < 0.05$, One-way ANOVA).

Observations and measurements indicated that the fish activity and feeding decreased with increasing doses of estradiol and at the end of period the mean length of fish in all groups was lower than control group.

4. Discussion

Estradiol plays an important role in female fish, promoting gonadal growth and development[4,12]. Today directly feminization is done in many fish species, in many different ways. Regardless of the method used, a general principle concerning all species is common and it is hormone therapy should be carried out during the sexual differentiation period of fish. After that the time of this period was determined for desired species, to achieve the highest efficiency of hormone effect, the maximum amount of the hormone which does not lead to adverse outcomes (reduced length and weight growth) should be used in the shortest possible

time.

Among the different doses studied, it was found that the negative effects of estradiol on nutritional behaviors and subsequent growth increased by dose increasing. The overall decline in growth indexes in fish, especially length and weight growth, is from hormone therapy characteristics using estrogen in high doses for long periods of time[8].

Results clearly suggest a distinct negative interplay between the growth and reproductive axis at the molecular level of key hepatic regulatory pathways involved in the control of energy utilization by gonadal and somatic growth processes[13]. Some researchers reported that the effect of sex hormones on fishes is different based on the fish species, fish ages and doses of hormone[14-16].

Hoseini and Tarkhani indicated that estradiol had no significant effect on rainbow trout (*Oncorhynchus mykiss*) and *Salmo salar* growth, also Brion *et al.* indicated use of estradiol delayed rainbow trout growth[17,18]. Some other researchers reported estradiol had negative effect on brook trout, carp and Atlantic salmon growth[19-21]. Lerner *et al.* found when Atlantic salmon affected by high levels of the estradiol hormone, growth might be reduced[22]. Balali *et al.* also observed this effect on female pink salmon (*Oncorhynchus gorbuscha*)[23]. Organic damages and reducing of the growth rate in exposure of estradiol was reported in previous research. Physical deviation and growth retardation were reported in Atlantic halibut (*Hippoglossus hippoglossus*) fed with 10 mg estradiol/kg diet for 45 d[24]. In this regard, Balali *et al.* indicated the use of 17-beta-estradiol applied with feed, had no significant effect on growth performance and survival rate[23].

Differences among the results of this study with some other researches could be explained by the differences in application time, doses and fish species.

Observations and measurements in this study indicated increasing the dose of 17-beta-estradiol reduced activity and nutrition of goldfish, as well as the average length and weight reduced similarly and use of this hormone had a negative effect on these two factors in goldfish. So application of this kind of estradiol do not recommended for *C. auratus*.

Conflict of interest statement

We declare that we have no conflict of interest.

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Comments

Background

17-Beta-estradiol is the natural estrogen in the fish blood and in teleosts, is responsible for the growth and maturation of the oocytes. It has been shown to be useful feminization hormone in some fishes.

Research frontiers

This research was conducted to investigate the effect of dietary 17-beta-estradiol on growth factors in goldfish (*C. auratus*).

Related reports

17-Beta-estradiol increase growth in yellow perch (*Perca flavescens*) through stimulating the appetite. Some researchers reported that the effect of sex hormones on fishes is different based on the fish species, fish age and dose of hormone. Some other researchers reported 17-beta-estradiol had negative effect on brook trout, carp and Atlantic salmon growth.

Innovations and breakthroughs

Effects of different doses 17-beta-estradiol on fish goldfish and check on other factors, growth factors could be important for aquaculture.

Applications

Observations and measurements in this study indicated increasing the dose of 17-beta-estradiol reduced activity and nutrition of goldfish, as well as the average length and weight reduced similarly and use of this hormone had a negative effect on these two factors in goldfish. So application of this kind of estradiol do not recommended for *C. auratus*.

Peer review

This is a valuable research which indicate with increase in the length and weight, the effects of the hormone get more distinct, so that with increase concentration of hormone, weight and length reduce. 17-Beta-estradiol along with testosterone and progesterone regulates final stages of oocyte maturation and ovulation. Various studies have proven the different concentrations of this hormone has different effects on the growth of different fishes. The aim of this study was to assess the effects of this hormone on growth factors of goldfish.

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