Journal of Coastal Life Medicine

journal homepage: www.jclmm.com

Document heading doi: 10.12980/JCLM.3.201514J48

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

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PEER REVIEW

Peer reviewer

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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. The aim of this study was to assess the effects of this hormone on growth factors of *Carassius auratus*.

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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Foundation Project: Supported by the Gorgan University of Agriculture Science & Natural Resource (Grant No. 6177515-5).

Article history:
Received 2 Jun 2014
Received in revised form 10 Jun, 2nd revised form 19 Jun, 3rd revised form 25 Jun 2014
Accepted 20 Aug 2014
Available online 6 Feb 2015

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)	$0.24^{a}\pm0.03$	$0.81^{a}\pm0.13$	$1.81^{a}\pm0.18$
Group 2 (10 mg/kg food)	$0.24^{a}\pm0.02$	$0.80^{ab}\pm0.14$	$1.66^{b}\pm0.17$
Group 3 (25 mg/kg food)	$0.24^{a}\pm0.02$	$0.77^{bc}\pm0.09$	$1.65^{b}\pm0.13$
Group 4 (50 mg/kg food)	$0.24^{a}\pm0.04$	$0.75^{c}\pm0.11$	$1.51^{c}\pm0.14$

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)	$0.11^{a}\pm0.02$	$0.27^{a}\pm0.05$	$1.07^{a}\pm0.13$
Group 2 (10 mg/kg food)	$0.11^{a}\pm0.02$	$0.25^{a}\pm0.04$	$1.01^{b}\pm0.06$
Group 3 (25 mg/kg food)	$0.11^{a}\pm0.02$	$0.23^{a}\pm0.06$	$0.99^{bc}\pm0.11$
Group 4 (50 mg/kg food)	$0.11^{a}\pm0.03$	$0.22^{a}\pm0.03$	$0.98^{c}\pm0.08$

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.

Acknowledgements

This work was funded by the Gorgan University of Agriculture Science and Natural Resource (Grant No. 6177515-5) and also technical and financial facilities were providing in the GUASNR.

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.

References

[1] Riede K. Global register of migratory species-from global to regional scales [dissertation]. Gaza: Islamic University; 2011.

[2] Tarkhani R, Imanpoor MR, Taghizadeh V. Effect of dietary 17-β -estradiol on serum sex hormones 'lvels and gamete quality in goldfish (*Carassius auratus*). *World J Fish Mar Sci* 2012; **4**(6): 637-644.

[3] Tintos A, Gesto M, Alvarez R, Míguez JM, Soengas JL. Interactive effects of naphthalene treatment and the onset of vitellogenesis on energy metabolism in liver and gonad, and plasma steroid hormones of rainbowtrout *Oncorhynchus mykiss*. *Comp Biochem Physiol C Toxicol Pharmacol* 2006; **144**(2): 155-165.

[4] Wang HP, Gao ZX, Beres B, Ottobre J, Wallat G, Tiu L, *et al*. Effects of estradiol-17β on survival, growth performance, sex reversal and gonadal structure of bluegill sunfish *Lepomis macrochirus*. *Aquaculture* 2008; **285**(1-4): 216-223.

[5] Pérez Carrera E, García-López Á, Martín del Río MP, Martínez-Rodríguez G, Solé M, Mancera JM. Effects of 17β-estradiol and 4-nonylphenol on osmoregulation and hepatic enzymes in gilthead sea bream (*Sparus auratus*). *Comp Biochem Physiol C Toxicol Pharmacol* 2007; **145**(2): 210-217.

[6] Arslan T, Phelps RP. Directing gonadal differentiation in bluegill, *Lepomis marochirus* (Rafinesque), and black crappie, *Pomoxis nigromaculatus* (Lesueur), by periodic estradiol-17β immersions. *Aquacult Res* 2004; **35**(4): 397-402.

[7] Breves JP, Fox BK, Pierce AL, Hirano T, Grau EG. Gene expression of growth hormone family and glucocorticoid receptors, osmosensors, and ion transporters in the gill during seawater acclimation of *Mozambique tilapia*, *Oreochromis mossambicus*. *J Exp Zool A Ecol Genet Physiol* 2010; **313**(7): 432-441.

[8] Krol J, Poblocki W, Bockenheimer T, Hilwa P. Effect of diethylstilbestrol (DES) and 17β-estradiol (E2) on growth, survival and histological structure of the internal organs in juvenile European catfish *Silurus glanis* (L.). *Aquaculture Int* 2014; **22**(1): 53-62.

[9] Lahnsteiner F, Berger B, Kletzl M, Weismann T. Effect of 17beta-estradiol on gamete quality and maturation in two salmonid species. *Aquat Toxicol* 2006; **79**(2): 124-131.

[10] Shved N, Berishvili G, D'Cotta H, Baroiller JF, Segner H, Eppler E, *et al*. Ethinylestradiol differentially interferes with IGF-I in liver and extrahepatic sites during development of male and female bony fish. *J Endocrinol* 2007; **195**(3): 513-523.

[11] Flynn SR, Benfey TJ. Effects of dietary estadiol-17β in juvenile shortnose sturgeon, *Acipenser brevirostrum*, Lesueur. *Aquaculture* 2007; **270**(1-4): 405-412.

[12] Schubert S, Peter A, Burki R, Schönenberger R, Suter MJ, Segner H, *et al*. Sensitivity of brown trout reproduction to long-term estrogenic exposure. *Aquat Toxicol* 2008; **90**(1): 65-72.

[13] Davis LK, Hiramatsu N, Hiramatsu K, Reading BJ, Matsubara T, Hara A, *et al*. Induction of three vitellogenins by 17beta-estradiol with concurrent inhibition of the growth hormone-insulin-like growth factor 1 axis in a euryhaline teleost, the tilapia (*Oreochromis mossambicus*). *Biol Reprod* 2007; **77**(4): 614-625.

[14] Cakmak G, Togan I, Severcan F. 17Beta-estradiol induced compositional, structural and functional changes in rainbow trout liver, revealed by FT-IR spectroscopy: a comparative study with nonylphenol. *Aquat Toxicol* 2006; **77**(1): 53-63.

[15] Breves JP, Seale AP, Helms RE, Tipsmark CK, Hirano T, Grau EG. Dynamic gene expression of GH/PRL-family hormone receptors in gill and kidney during freshwater-acclimation of *Mozambique tilapia*. *Comp Biochem Physiol A Mol Integr Physiol* 2011; **158**(2): 194-200.

[16] Hayward RS, Wang HP. Rearing male bluegills indoors may be advantageous for producing food-size sunfish. *J World Aquacult Soc* 2006; **37**: 496-508.

[17] Hoseini SM, Tarkhani R. Effect of short term treatment with potassium permanganate on stress markers and blood biochemistry in goldfish *Carassius auratus*. *Aquacult Res* 2013; **44**(6): 869-875.

[18] Brion F, Tyler CR, Palazzi X, Laillet B, Porcher JM, Garric J, *et al*. Impacts of 17beta-estradiol, including environmentally relevant concentrations, on reproduction after exposure during embryo-larval-, juvenile- and adult-life stages in zebrafish (*Danio rerio*). *Aquat Toxicol* 2004; **68**(3): 193-217.

[19] Yang L, Lin L, Weng S, Feng Z, Luan T. Sexually disrupting effects of nonylphenol and diethylstilbestrol on male silver carp (*Carassius auratus*) in aquatic microcosms. *Ecotoxicol Environ Saf* 2008; **71**(2): 400-411.

[20] Arsenault JT, Fairchild WL, MacLatchy DL, Burridge L, Haya K, Brown SB. Effects of water-borne 4-nonylphenol and 17-beta estradiol exposure during parr-smolt transformation on growth and plasma IGF-I of Atlantic salmon (*Salmo salar* L.). *Aquat atoxicol* 2004; **66**(3): 255-265.

[21] Campbell B, Dickey J, Beckman B, Young G, Pierce A, Fukada H, *et al*. Previtellogenic oocyte growth in salmon: relationships among body growth, plasma insulin like growth factor-1, estradiol-17beta, follicle-stimulating hormone and expression of ovarian genes for insulin-like growth factors, steroidogenic acute regulatory protein and receptors for gonadotropins, growth hormone and somatolactin. *Biol Reprod* 2006; **75**(1): 34-44.

[22] Lerner DT, Björnsson BT, McCormick SD. Larval exposure to 4-nonylphenol and 17beta-estradiol affects physiological and behavioral development of seawater adaptation in Atlantic salmon smolts. *Environ Sci Technol* 2007; **41**(12): 4479-4485.

[23] Balali S, Sudagar M, Hoseini SA, Kordi H. The effect of 17beta-estradiol on growth and survival of sword tail (*Xiphophorus helleri*). *World J Fish Mar Sci* 2012; **4**(4): 335-339.

[24] Hendry CI, Martin-Robichaud DJ, Benfey T-J. Hormonalsex reversal of Atlantic halibut (*Hippoglossus hippoglossus* L.). *Aquaculture* 2003; **219**(1-4): 769-781.