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CHANGES IN BODY WEIGHT GAIN OF BLUE TILAPIA, *OREOCHROMIS AUREUS* DURING LONG-TERM EXPOSURE TO SUBLETHAL CONCENTRATIONS OF FORMALIN

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Abstract

The effect of sublethal concentrations of formalin on the weight gain of blue tilapia fingerlings was investigated under laboratory conditions during a 12 weeks exposure period at concentrations of 32, 16, 8, 4, 2 mg/l and 0.00 (control). Due to this exposure, the weight gain was depressed in the fish. This depression was directly proportional to the formalin concentrations. However, at 2 mg/l concentration, no significant depression in weight gain ($P>0.05$) was observed in the tested fish. Precautions in the successful use of formalin in the treatment of external bacterial and parasitic infections in aquaculture fields are discussed.

INTRODUCTION

Formalin is widely used in aquaculture fields as a traditional treatment for fish ectoparasites (Roberts and Shepherd, 1974, Schnick, 1974). It is usually to apply formalin treatment at concentrations of 167-250 mg/l for 1 hour (Roberts, 1978). Since formalin is toxic to fish, care must be taken in its use. In practice, high losses sustained during/or subsequent to treatment are sometimes attributable to errors, such as incorrect dosage or too frequent repetition of the treatment. However, mortalities may occur quite unpredictably even when such compounds are administered correctly (Piper and Smith, 1973). It is applied by both, flush or flowing treatment methods and has proved effective against most ectoparasitic protozoan and some monogeneans. A concentration of 500 mg/l for 30 minutes has proved effective against the salmon louse, *Lepeophlheirus salmonis* (Hastein and Bergsjo, 1976). Meyer and Collar (1964) noted that it could be used at 25 mg/l for an indefinite length of time in bath treatment.

Some disinfectants for the treatment of ectoparasites on cultivable fish species have been known to have cumulative adverse effects on the fish. Wedemeyer (1971), attempted to quantify the stress of chemical treatments in rainbow trout, *Oncorhynchus mykiss*, and coho salmon, *O.Kisutch* and there seemed little doubt that repeated

use of disinfectants such as formalin will cause considerable damage to gill epithelia.

Smith and Piper (1972), reported that, 167 mg/1 of formalin destroyed and desquamated the gill epithelium of the rainbow trout. Omoregie *et al.* (1994), observed that the Nile tilapia exposed to sublethal concentrations of formalin had anaemia and hyperglycemia. Secondary effects on physiology and metabolism may persist after treatment and contribute to decreased resistance to disease and other stresses (Wedemeyer, 1970, Wedemeyer and Wood, 1974 and Mazeaud *et al.*, 1977).

The blue tilapia, which is a common fish in tropical freshwaters (like in Egypt), is widely used in aquaculture in several African and Asian countries, hence, its choice for this investigation. The objective of this investigation is to evaluate the effects of sublethal doses of formalin on weight gain in blue tilapia.

MATERIALS AND METHODS

Fingerlings of the blue tilapia (Mean weight, 2.03 + 0.006 g) were acclimatized to laboratory conditions for one week prior to exposure. Mortality was less than 5% during the acclimatization period. Twelve fingerlings were stocked in each aquarium with dechlorinated areated tap water. Feeding was done once daily using a pelleted diet at a rate of 3% of body weight of the fish. The experimental set-up consisted of twelve 112.5 Liter aquaria. The water was changed once every four days to remove accumulated faecal material and unconsumed feed.

Formalin was added as 40% formaldehyde. The following concentrations were delivered into each of the first six aquaria:32.00,16.00, 8.00, 4.00, 2.00 and 0.00 mg/l. The remaining six aquaria served as replicates. To prevent problems associated with the degradation of formalin in the various experimental aquaria, fresh concentrations were delivered into each of the aquaria on a daily basis.

The exposure period was 12 weeks, during which the following water quality parameters: pH, dissolved oxygen, temperature, alkalinity and unionised ammonia in each of the test aquaria were monitored weekly according to APHA/AWWA / WPCF (1980).

The proximate composition of the pelleted diet fed to the exposed fish was determined according to AOAC (1980) as shown in Table 1. The fish were individually weighed at the start of the exposure period and every two weeks. Mean weight gain of the fish was computed per treatment for each weighing period. The amounts of feed given were adjusted to the new weight.

Table 1. Proximate analysis of experimental diet (% dry weight) fed to the blue tilapia *Oreochromis aureus* during long-term exposure to sublethal concentrations of formalin for 12 weeks.

Components	Composition
Protein	55.3 ± 0.26
Water content	9.24 ± 0.24
Total lipids	3.84 ± 0.58
Ash	7.65 ± 0.40

- Data are represented as mean ± S.E.

Results were subjected to statistical analysis with the Duncan's multiple range F-test to test for the level of significance at 0.05 of probability within the various concentrations according to the methods described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The water quality parameters in the various test aquaria did not vary significantly ($P > 0.05$) from those of the control groups during the exposure period (12 weeks) (Table 2). This finding was found to be in agreement with that found by Makereth (1963). The proximate composition of the experimental diet showed a high protein content (55.3%) (Table1). Fish exposed to the toxicant had curbed appetite. However, with slow feeding, all fish eventually consumed the food supplied. Table 3 showed the mean weight gain of the exposed fish to the various concentrations. Statistical analysis showed that the test fish exposed to the various sublethal concentrations of formalin had significantly lower weight gain that those of the control fish ($P<0.05$) with depression in weight gain, being directly proportional to toxicant concentrations and sampling periods. The weight gains over the 12 weeks exposure period were 3.52, 4.03, 6.22, 6.22, 6.79, 8.02 and 9.30 g with concentrations of 32,16,8,4,2 and 0.00 mg/l of formalin, respectively. These results are in accordance with those observed by Chinabat *et al.* (1987) using common carp exposed to Dipterex (insecticide).

The obtained results could be due to that, sublethal concentrations of toxicants had marked disturbances on the physiological activities, and consequently, reduced growth rate (Marie *et al.*, 1994 and Zaghloul, 1997). These disturbances would de-

crease the efficiency of the exposed fishes in maintaining physiological homeostasis (Letti *et al.*, 1976 and Waiwood & Beamish, 1978).

The suppression of growth may be due to adverse effects of formalin on normal metabolism of the fish. Omoregie *et al.* (1994) have reported that Nile tilapia exposed to sublethal concentrations of formalin had anaemia and hyperglycaemia at the end of the exposure period. On the other hand, the suppressive effect of the toxicant on nutrient digestibility as earlier reported by Ufodike & Omoregie 1991) could not be ruled out.

Formalin is widely recommended for treatment of ectoparasitic infections of farmed fish species (Roberts, 1978). Although its effects against ectoparasites are encouraging, however, the deleterious consequences on the growth of fish subjected to nominal chronic exposure to formalin calls for the review of its use in aquaculture. Optimal caution should also be observed when formalin is used against ectoparasites (Omoregie *et al.*, 1998). Based on the results obtained in this investigation, it could be recommended that formalin could be applied as disinfectant against fish ectoparasites at doses of 2 mg/l.

Table 2. Mean water quality criteria obtained during long-term exposure of the blue tilapia *Orochromis aureus* to sublethal concentrations of formalin for 12 weeks.

Formalin conc. mg/1 / Parameters	0.00 (Control)	2.00	4.00	8.00	16.00	32.00
pH	8.27±0.089	7.96±0.046	7.84±0.033	7.75±0.05	7.45±0.07	7.34±0.066
Dissolved Oxygen (mg/1)	6.01±0.098	5.97±0.033	5.87±0.05	5.97±0.07	6.01±0.044	5.82±0.049
Temperature (ºC)	24.17±0.088	24.3±0.058	24.3±0.088	24.2±0.09	24.1±0.058	24.3±0.06
Total hardness (mg/1 as $CaCO_3$)	144.7±1.76	145.3±1.20	145.7±2.03	147.0±1.45	144.0±1.15	146.0±1.53
Total alkalinity (mg/1 as $CaCO_3$)	0.344±0.004	0.349±0.003	0.345±0.04	0.358±0.003	0.346±0.007	0.361±0.003
Ammonia (NH_3) mg/1	0.15±0.015	0.14±0.02	0.16±0.018	0.17±0.018	0.19±0.017	0.15±0.02

- Data are represented as mean ± S.E.

Table 3. Mean waight gain (g) of the blue tilapia *Oreochromis aureus* exposed to sublethal concentrations of formalin for 12 weeks.

Formalin conc. mg/1 / Time (week)	0.00 (Control)	2.00	4.00	8.00	16.00	32.00
0	2.00±0.007a	2.02±0.009a	2.04±0.006a	2.03±0.007a	2.03±0.007a	2.04±0.014a
2	3.46±0.01a	3.21±0.06b	3.01±0.004c	2.73±0.009d	2.42±0.008e	2.29±0.008ef
4	4.92±0.007a	4.39±0.006b	3.94±0.006c	3.41±0.01d	2.82±0.008e	2.54±0.013f
6	6.35±0.006a	5.61±0.007b	4.86±0.005c	4.11±0.006d	3.21±0.008e	2.80±0.008f
8	7.83±0.009a	6.83±0.009b	5.80±0.006c	4.80±0.007d	3.64±0.009e	3.31±0.01f
10	9.30±0.007a	8.02±0.009b	6.79±0.008c	6.22±0.009d	4.03±0.009e	3.52±0.012f
12	10.77±0.013a	9.17±0.011b	7.68±0.011c	6.90±0.01d	4.41±0.01e	3.75±0.014f
Weight gain	8.77	7.15	5.64	4.87	2.38	1.71

-Data are represented as mean ± S.E.
-Total numbers of fish used per interval = 8
-Mean with the same letters in the same row are not significantly different (P>0.05).

REFERENCES

1. AOAC. (Association of Official Analytical Chemists) 1980. Official methods of analysis of the analysis of the AOAC. Association of official Analysis Chemists, Washington, DC. PP. 858.

2. APHA/AWWA/ WPCF. (American Public Health Association, American Water Works Association, Water Pollution Control Federation) 1980. Standard methods for the examination of water and waste water. American Public Health Association, Washington, DC. PP. 1268.

3. Chinabut, S., C. Limsuwan and S. Kauchana-Khan. 1987. Toxic and sublethal effects of Dipterex on freshwater fishes. Network of Aquaculture Centres in Asia, NACA, WP/8756, Thailand. PP. 21.

4. Hastein, T. and T. Bergsjo. 1976. The salmon lice, *Lepeopheirus salmonis* as the cause of disease in farmed salmonids. Rivista Italian di Piscicoltura e Ittiopatologia, 11:3-5.

5. Letti, P.E., G.J. Farmer and F.W.H. Beamith. 1976. Effect of copper on some aspects of the bioenergetics of rainbow trout, *Salmo gairdneri*. J. Fish Res. Bd. Com., 33:1335-1342.

6. Makereth, F.J.H. 1963. Some methods of water analysis for limnologists. Freshwater Biological Association Scientific Publication, No. 21, pp. 70.

7. Marie, M.A.S., A.M. Haggag and K.H. Zaghloul. 1994. Haematological response induced by hypoxic underground water in common carp, *Cyprinus carpio* and Nile catfish, *Clarias lazera*. J. Egypt. Ger. Soc. Zool., 13 (A): 295-319.

8. Mazeaud, M.M., F. Mazeaud and E.M. Donaldson 1977. Primary and Secondary effects of stress in fish: Some new data with a general review. Trans. Am. Fish, Soc., 106:201-212.

9. Meyer, F.P. and J.D. Collar. 1964. Description and treatment of *Pseudomonas* infection in white catfish. Applied Microbiology, 12:201-203.

10. Omoregie, E., P.C. Ofojekwu and E.I. Amali. 1998. Effect of sublethal concentrations of formalin on weight gain in the Nile tilapia, *Oreochromis niloticus* (Trewavas). Asian Fisheries Science, 10:323-327.

11. Omoregie, E. T.G. Eseyin and P.C. Ofojekwu. 1994. Chronic effects of formalin on erythrorcyte counts and plasma glucose of the Nile tilapia, *Oreochromis niloticus*. Asian Fisheries Science, 7:1-6.

12. Piper, R.G. and C.E. Smith. 1973. Factors influencing formalin toxicity in trout. Prog. Fish Cult., 35:78-81.

13. Roberts, R.J. 1978. Fish pathology. Baillier Tindall, London. PP. 318.

14. Roberts, R.J. and C.J. Shepherd. 1974. Handbook of Trout and Salmon diseases. Fishing news (Books), West By Fleet, PP. 168.

15. Schnick, R.A. 1974. Formalin as a therapeutant in fish culture. U.S. fish wildl. Serv., Lit. Rev., 774-09 NTIS (Nat. Tech. Infor. Serv.) No. PB-235448/As PP 145.

16. Smith, C.E. and R.G. Piper. 1972. Pathological effects of formalin treated rainbow trout, *Salmo gairdneri*. journal of the Fisheries Research Board of Canada, 29:328-329.

17. Steel, R.G.D. and J.H. Torrie. 1980. Principles and procedures of statistic 2 nd ed. McGraw-Hill Book Company, Now York, USA.

18. Ufodike, E.C. and E. Omoregie. 1991. Growth of *Oreochromis niloticus* subjected to sublethal concentrations of Gammalin 20 and Actellic 25 EC in a continuous-flow Toxicant autodelivery system. Aqua. Anim. H. 3:221-231.

19. Waiwood, K.G. and F.W.H. beamish. 1978. The effect of copper hardness and pH on the growth rainbow trout; *Salmo gairdneri*. J. Fish Biol., 13:591-598.

20. Wedemeyer, G. 1971. The stress of formlin treatment in rainbow trout, *Salmo gairdneri* and Coho salmon, *Oncorhynchus Kisutch*. Fish. Res. Board Canada, 30:831-834.

21. Wedemeyer, G.A. 1970. The role of stress in the disease resistance of fishes. In: S.F. Snieszko (Editor),A symposium on Diseases of Fisheries and Shellfishes. Special Publication No. 5 American Fishes Society Washington, DC, PP. 30-35.

22. Wedemeyer, G.A. and J.W. Wood. 1974. Stress as a predisposing factor in fish diseases. U.S. fish and Wildlife service, Washington, DC. Fisheries leaflet No., 38, PP. 7.

23. Zaghloul, K.H. 1997. Studies on the effect of water pollution along different sites of the river Nile on the survival and production of some freshwater fishes. Thesis, Ph.D. Fac. Sci., Cairo University,Egypt.

التغيرات فى وزن سمكة البلطى الأزرق (*إريوكرومس أوريس*) عند التعرض طويل المدى لتركيزات تحت المميتة من الفورمالين

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المعمل المركزي لبحوث الأسماك بالعباسة- مركز البحوث الزراعية - وزارة الزراعة - الجيزة - مصر.

أجريت هذا التجربة بمعامل المعمل المركزي لبحوث الثروة السمكية بالعباسة - أبو حماد - محافظة الشرقية والتابع لمركز البحوث الزراعية وكان الهدف من هذه التجربة هو دراسة تأثير تركيزات تحت المميتة من الفورمالين على وزن سمكة البلطى الأزرق (*إريوكرومس أوريوس*) حيث جرت العادة على إستخدام الفورمالين بتركيزات مختلفة لمدد مختلفة لمقاومة وعلاج العدوى الطفيلية والبكتيرية الخارجية والبكتيرية الخارجية على الأسماك .

تم إستخدام خمس تركيزات تحت المميتة هى ٣٢ ، ١٦ ، ٨ ، ٤ ، ٢ ملليجرام / لتر بالأضافة إلى مجموعة مقارنة بدون فورمالين . المجموعة الضابطة).

وأظهرت النتائج إنخفاض أوزان الأسماك كلما زاد تركيز الفورمالين وكانت الأختلافات فى الوزن معنوية ($P>0.05$) فى كل مراحل النمو عدا تركيز ٢ ملليجرام / لتر مقارنة بالمجموعة الضابطة.