

Effect of Water Hardness on Growth, Survival, Hematocrit and Some Blood Biochemical Indices of Kutum (*Rutilus frisii kutum*) Fingerlings

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Abstract: The responses to water hardness augment varies from species to species. The aim of this research was to verify the growth, survival, hematocrit and some biochemical indices change in Kutum (*Rutilus frisii kutum*) fingerlings in water with different levels of hardness. Fingerling fish (2 ± 0.1 g) were randomly distributed to trial units (three replicates per treatment) and kept in 15 aquaria (20 fingerlings/aquarium). Fingerlings were exposed to five water hardness amounts (30, 70, 150, 300 and 600 mg/L CaCO_3) at pH=8.45. At the end of trial, FCR (feed conversion ratio), specific growth rate (SGR), final biomass, hematocrit, calcium, potassium, sodium, magnesium, glucose, cholesterol and total protein were concluded for each collection. Higher fingerling growth, survival, weight gain and final biomass were obtained 70 and 150 mg/L CaCO_3 . Hence, this is the suggested hardness range for growth and survival of Kutum fingerlings.

Key words: Blood Biochemistry % Survival % Growth % Water Hardness % Kutum

INTRODUCTION

Kutum (*Rutilus frisii kutum*) is one of the economically important fishes of the Caspian Sea. They are mainly distributed in the southern part of the Caspian Sea, particularly in the region from Astara to Gorgan River and migrate into rivers for spawning. Kutum have two life histories; there are spring and autumn migratory populations. The fish spawn on aquatic plants and river sands [1].

Total hardness is the concentration of all divalent cations in water and Ca^{2+} & Mg^{2+} are the most common cations in nearly all freshwater systems. The suggested value for water hardness for fish culture in ponds is above 20 mg/L CaCO_3 [2], principally because of its effect on phytoplankton growth and water pH control. However, Ca^{2+} is necessary for fish for some biological processes such as bone construction, blood coagulation, and multiple other cellular functions [3]. The internal source of Ca^{2+} in fish is not easily accessible. Hence, plasma Ca^{2+} was controlled by its ingestion with food or by branchial absorption [4].

Skeletal growth in vertebrates is frequently limited by the obtainability of fundamental nutrients and minerals [5]. In particular, calcium, the primeval component of the classified collagen matrix forming the bone skeleton of more vertebrates, is necessary to suitable growth and development. Difference in the attainability of calcium in the aquatic environment places constraints on the speed and scope of larval development in fishes [3], can stunt growth and can place extra stresses on fish transplanted from a calcium-rich to a low-calcium environment.

MATERIALS AND METHODS

300 fingerling fish of Kutum produced at the Sijoval area, Golestan, Iran were acclimated to laboratory conditions for 30 days before being randomly distributed into 15 experimental 70-L aquaria which supplied with freshwater from an urban system. The aquaria were individually aerated and water temperature was controlled at $23 \pm 1^\circ\text{C}$. Dissolved oxygen, pH and water temperature were continuously monitored. Photoperiod was maintained at 12-h light: 12-h dark cycle.

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Length, weight of fish and water salinity were calculated by biometry board ($\pm 1\text{mm}$), balance ($\pm 0.01\text{g}$) and water checker (HORIBA, U-10, Japan) respectively. Water K^+ and Na^+ ions were calculated by flame photometer (Jenwayfpf 7, England), water Mg^{2+} and Ca^{2+} were measured by spectrophotometer (S2000-U V/IS England) [6].

pH was measured by pH meter; EC (electrical conductivity) was measured by water checker (HORIBA, U-10, Japan) and total hardness was measured by titration method in Central Laboratory of Gorgan University of Agricultural Sciences and Natural Resources.

Whole-body specific growth rates (SGR), expressed as a percentage of the body weight was calculated using the growth rate equation of Turker *et al.* [6]:

$$\text{SGR}(\%/ \text{day}) = \{[\ln(W_f) - \ln(W_i)].100\} / t$$

where (W_i) and (W_f) are the initial and final wet weights (g) of the experimental Kutum, respectively and (t) is the length of the experimental period (in days).

The feed conversion ratio (FCR) was calculated in terms of wet weight as:

$$\text{FCR} = \text{wet weight of feed consumed} / \text{change in wet weight}$$

$$\text{Survival}(\%) = \text{Total live fish (No.) after } t / \text{Total fish at 0 day (No.)} \cdot 100$$

The quantitative determination of plasma glucose were carried out using commercially available diagnostic experimental protocols kits Pars Azmoon, Iran, at 546 nm and $37\text{ }^\circ\text{C}$ by the glucose oxidase method [7]. Glucose was measured photo metrically according to a method modified from Lovson [5]. based on the quantification of NADH after a glucose oxidation catalyzed by glucose dehydrogenase.

Plasma total protein and cholesterol levels were determined spectrophotometrically using commercial kits Sigma 337-B and Sigma 401- 25P by the method of Hedayati *et al.* (2010). Calcium (Ca) values were measured by cresophthaleincomplexone [8]. Phosphor values were measured by a colorimetric reaction as a combination of molybdate with phosphate in the presence of acid that forms a final product called molybdenum blue [9].

All data were analyzed with one-way analysis of variance (ANOVA) by using SPSS16.0 for windows. Differences between means were determined using Duncan's multiple test (significance at $P < 0.05$).

RESULTS

Plasma glucose, cholesterol, calcium, sodium, magnesium, potassium and total protein values are shown in Table 1. No statistically differences were observed in hematocrit and biochemical parameters including plasma cholesterol, calcium, sodium, magnesium, potassium and total protein values ($p > 0.05$) but Plasma glucose concentrations increased in 1, 2 and 5 treatment.

During the period of 56 days, fingerling fish maintained at water hardness of 70 and $150\text{ mgL}^{-1}\text{CaCO}_3$ showed greater weight gain, final biomass, SGR and survival also showed lowest FCR than the other treatments (Fig 1-5).

DISCUSSION

This research was guided to estimate the effects of changing water hardness on growth, survival, hematocrit and biochemical indices change of Kutum (*Rutilus frisii kutum*). Acquire sufficiently and appropriate food is the mainly pompous factor in aquaculture. Deviation in water quality, counteraction correlations of physicochemical factors with each other and fish high density may create popular ranges of physiological variations in fish [10].

Table 1: Hematocrit and Biochemical indices change of Kutum fingerlings fish exposed to different levels of water hardness

	Experimental treatment				
	Treatment1(30)	Treatment2(70)	Treatment3(150)	Treatment4(300)	treatment 5(600)
Hematocrit	45.00 \pm 1.00 ^a	45.83 \pm 1.50 ^a	43.00 \pm 1.00 ^a	43.00 \pm 1.00 ^a	45.66 \pm 1.52 ^a
Sodium	121.67 \pm 10.40 ^a	126.67 \pm 7.63 ^a	129.00 \pm 14.93 ^a	131.67 \pm 12.58 ^a	109.67 \pm 10.50 ^a
Potassium	3.83 \pm 0.76 ^a	4.33 \pm 0.76 ^a	4.50 \pm 1.32 ^a	4.26 \pm 0.68 ^a	4.30 \pm 0.72 ^a
Calcium	4.40 \pm 0.52 ^a	4.86 \pm 0.70 ^a	5.16 \pm 1.04 ^a	5.43 \pm 0.92 ^a	5.56 \pm 1.20 ^a
Magnesium	8.23 \pm 0.25 ^a	8.40 \pm 0.10 ^a	8.63 \pm 0.32 ^a	8.76 \pm 0.40 ^a	8.90 \pm 0.65 ^a
Glucose	95.66 \pm 13.65 ^a	90.00 \pm 5.00 ^{ab}	80.00 \pm 5.00 ^b	77.33 \pm 6.80 ^b	104.33 \pm 6.02 ^a
Cholesterol	0.55 \pm 0.05 ^a	0.49 \pm 0.02 ^a	0.48 \pm 0.03 ^a	0.49 \pm 0.05 ^a	0.49 \pm 0.08 ^a
Total protein	20.66 \pm 2.51 ^a	18.66 \pm 1.52 ^a	20.33 \pm 2.08 ^a	20.33 \pm 3.05 ^a	21.33 \pm 2.08 ^a

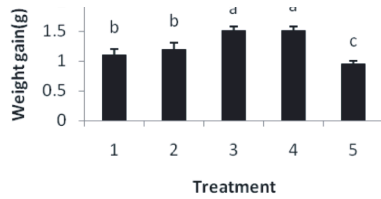


Fig. 1: Weight gain of Kutum after exposure to different levels of water hardness

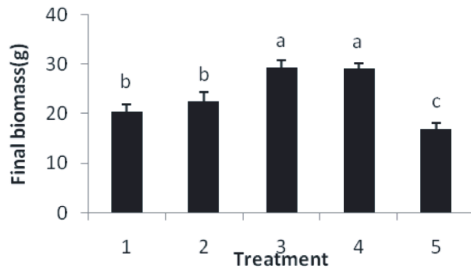


Fig. 2: Final biomass of Kutum after exposure to different levels of water hardness

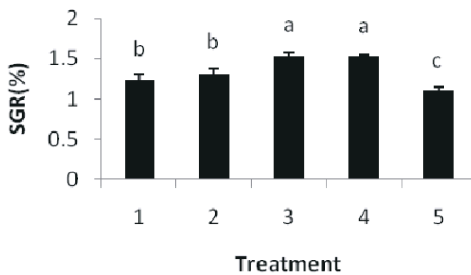


Fig. 3: SGR of Kutum after exposure to different levels of water hardness

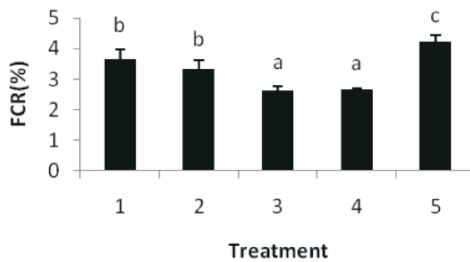


Fig. 4: FCR of Kutum after exposure to different levels of water hardness

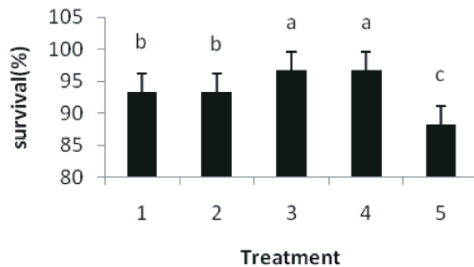


Fig. 5: Survival of Kutum after exposure to different levels of water hardness

Buttner *et al.* [2] informed that physicochemical factor effect on fish growth and they too effect on each other. In this study, significant and positive correlation was observed between hardness (70 and 150) with final weight, growth rate, FCR, hematocrit and biochemical indices. Loveson [5] propose that in hardness permissible domain, anything the water be harder it is appropriate for fish but out of this range fish indicatereduce in growth with enlarge in water hardness.

Loveson [5] established that an increase in water hardness decrease or removed of silver toxicity in early life levels of rainbow trout, while improvement fish survival. Hence in our research the highest survival rate was found at moderately hard water (70 and 150 mgL⁻¹ CaCO₃).

Plasma glucose levels had decreased in hardness 70 and 150 mgL⁻¹. Glucose is a carbohydrate that has a major role in the bioenergetics of animals, being transformed to chemical energy (ATP), which in turn can be expressed as mechanical energy [11]. Glucose is then released toward blood circulation and enters into cells through the insulin action [12]. Plasma glucose concentration depends on intestinal absorption, hepatic production and tissue uptake of glucose. Several hormones affect homeostasis of glucose, including insulin, glucagons, corticosteroids, adrenocorticotrophic hormone (ACTH), growth hormone and catecholamines. The maintenance of blood glucose concentrations occurs via hepatic glycogenolysis, glycolysis and gluconeogenesis [13].

Liming is suggested to stabilize low water pH, because calcium carbonate enlarges water buffering capacity [13]. For silver catfish, liming must not enlarge water hardness beyond 70 mg L⁻¹ CaCO₃, because this quantity is sufficiently to decrease the effect of acidic and alkaline pH on fingerlings [14].

In this research we found the highest survival rate in 70 and 150 mg/l CaCO₃, but Nelson & Cox (2005). studied the effects of water hardness on skeletal development and growth in juvenile fathead minnows and pointed that fathead minnows reared in calcium-abundant water (Ca=65±1.5 mgL⁻¹ as CaCO₃; hardness 175 mg/l) had significantly multiplied survival but lower whole body mass when compared to their conspecifics in low calcium water.

These results infer that hardness effects on water conditions for use in Kutum rearing and the best hardness range for survival and growth of Kutum fingerling fish is 70–150 mg LG⁻¹ CaCO₃.

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