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The correlation between water physicochemical and ionic parameters with growth indicators in *Rutilus frisii kutum*

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Abstract. In this study the correlation between water physicochemical (EC, pH, salinity, hardness) and ionic (Na^+, K^+, Ca^{2+} and Mg^{2+}) parameters with growth indicators in *Rutilus frisii kutum* within 3 months on 7 ponds (2 hectar) in Sijoval area in Golestan province were investigated. The range of water ionic composition were included (230-447.5 Mmol/l) Na^+, (11.5-28.8 Mmol/l) K^+, (0.04-22.44 mgr/dl) Ca^{2+} and (12.47-22.45 mgr/dl) Mg^{2+}. The pearson results were showed that there were significant correlation between first weight with Na^+ and salinity ($p<0.05$), growth ratio with second weight ($p<0.05$), water pH with k^+, Na^+, Mg^{2+} ($p<0.01$) hardness with hardness, Na^+ and Ca^{2+} ($p<0.01$), salinity with k^+ and Na^+ ($p<0.01$) and Na^+ with K^+ ($p<0.05$). So, between water physicochemical and ionic parameters with growth indicators, significant correlation was showed that with management and regulation these factors in suitable culture range, are caused growth increasing in *R. frisii kutum*.
Key Words: *Rutilus frisii kutum*, water physicochemical and ionic parameters, growth.

چکیده: در این مطالعه روابط برخی از خصوصیات فیزیکوشیمیایی آب (EC، pH، شوری، سختی) و ترکیبات یونی (سدیم، پتاسیم، کلسیم و منیزیوم) با شاخص رشد در ماهی سفید طی 3 ماه روی 7 استخر 2 هکتاری در منطقه سیجوال در استان گلستان مورد مطالعه قرار گرفت. محدوده ترکیبات یونی آب حاوی 447/5- 230 میلی مول در لیتر سدیم، 28/8- 11/5 میلی مول در لیتر پتاسیم، 22/44- 9/04 میلی گرم در دسی لیتر کلسیم و 22/45- 12/47 میلی گرم در دسی لیتر منیزیوم بود. نتایج حاصله از آماره پیرسون نشان داد که بین وزن اولیه با شوری و یون سدیم (P<0/05)، وزن ثانویه با نرخ رشد (P<0/05)، pH با یونهای پتاسیم، سدیم و منیزیوم (P<0/01)، سختی با شوری و یونهای کلسیم و سدیم (P<0/01)، شوری با یونهای سدیم و پتاسیم (P<0/01) و یون پتاسیم با یون سدیم (P<0/05) ارتباط معنی داری وجود داشت. بنابراین بین پارامترهای یونی و عوامل فیزیکوشیمیایی آب با رشد ارتباط معنی داری مشاهده شد که می توان با اطلاع از مقادیر مناسب پارامترهای ذکر شده در مورد هر ماهی و تعیین روابط حاکم بر آنها در استخرها، پرورش دهندگان را به سمت مدیریت بهتر و در نتیجه تولید بیشتر سوق داد.
کلمات کلیدی: ماهی سفید، پارامترهای فیزیکوشیمیایی آب، عوامل یونی، رشد

Introduction. Fish perform all their bodily functions in water, because fish are totally dependent upon water to breathe, feed, grow, excrete wastes, maintain a salt balance, and reproduce. Understanding the physical and chemical qualities of water is critical to successful aquaculture. To a great extent, water determines the success or failure of an aquaculture operation.

Kutum, *Rutilus frisii kutum* Kamensky (Cyprinidae), is one of the economically important fishes of the Caspian Sea. They are mostly distributed in the southern part of the Caspian Sea, especially in the area 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 (Razavi 1995, 1998).

Declines in the stocks and catch of kutum are caused by over-fishing, increased pollution, overexploitation of sands and sediments of the Caspian Sea, and the construction of bridges and dams that modify or block the natural spawning grounds.

Collection of kutum broodstocks from their natural spawning grounds by the Iran Fisheries Organization has also decreased the fishery resources in the area. Sijoval teleost propagation and nurture center is one of places where broodstock was collected for propagation with the fingerlings to be released back into the rivers where they naturally occur.

Sijoval teleost propagation and nurture center was constitute in 1996. The aim of this center is preservation and reforming the teleost of Caspian Sea. This center is located in Golestan province.

Water is the primary requisite for fish culture for survival and existence of fish and other aquatic organisms. The physicochemical factor of a particular water body has effects on the biota of that water body.

Several physicochemical or biological factors could act as stressors and adversely affect fish growth and reproduction (Iwama et al 2000). Hence, regular monitoring of physicochemical and biological water quality parameters is essential to determine status of lakes with reference to fish culture.

Environmental stresses are the important factors that restrict fish condition under cultured situation (Pickering 1992; Wendelaar Bonga 1997; Ellis et al 2002).
Salinity is the most common environmental factor that can influence osmoregulation in fish, but osmoregulation system in fish can't only be dependent on salinity, that's why, for excellent culture of cultured cyprinid fish, water quality have to be under complete management (Huet 2000). Salinity and its variations are among the key factors that affect survival, metabolism, and distribution during the fish development (Varsamose et al 2005).

Alkalinity and hardness are both important components of water quality. Hardness represents the overall concentration of divalent salts (calcium, magnesium, iron, etc.).
Water ionic parameters influence aquatic environment and they have undoubted role on fish (Flik et al 1994; Gardeur et al 2007).

The lack of a necessary mix of essential ions, including potassium (K^+) and magnesium (Mg^{2+}), in environmental water has been demonstrated to limit fishes growth and survival (Davis et al 2005). K^+ is one of the intercellular cation and also is important in Na^+, K^+-ATPase activity. This ion has equilibrium with extracellular K^+. The lack of water K^+ levels can influence osmoregulation power (Pequeux 1995; Marshall 2002). Sodium (Na^+) pump by hydrolysis one molecule ATP, intern 2 ions of K^+ and exit 3 ions of Na^+ (Mobasheri 2000).

Mg^{2+} as a cofactor has relationship with Na^+, K^+-ATPase activity (Pequeux 1995; Furriel et al 2000). Mg^{2+} also plays a role in the normal metabolism of lipids, proteins, and carbohydrates serving as a cofactor in a large number of enzymatic and metabolic reactions (Davis & Lawrence 1997; Davis et al 2005). Both K^+ and Mg^{2+} are ions essential for normal growth, survival, and osmoregulatory function of crustacean and fishes (Davis et al 2005).

Management of alkalinity and hardness, stable pH variations, save necessary phosphate for phytoplankton, increase pond's natural food, and assemble necessary calsium (Ca^{2+}) for osmoregulation, egg hardness, and other metabolic requirements (Roy et al 2007).

The objective of this study was to determination of correlation between water physicochemical and ionic parameters with growth indicators in *R. frisii kutum.*

Material and Method. This research was carried out within months of March 2009 to June 2010 in 7 ponds (2 hectars) in Sijoval area of Golestan province. In definite intervals (twice every month) sampling were carried out 3 times in every pond from water and fish. At the end of culture and at the beginning of harvesting, average weight (g) of fish in each pond were measured.

Fish length, fish weight and water salinity were measured by biometry board (±1mm), balance (±0.01 g) and water checker (HORIBA, U-10, Japan) respectively.

Water K^+ and Na^+ ions were measured by flame photometer (Jenway pfp 7, England), water Mg^{2+} and Ca^{2+} were measured by spectrophotometer (S2000-UV/IS England) (Turcker et al 2004).

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 Gorgan University of Agricultural Sciences And Natural Resources Central Laboratory.

Growth rate in this research was calculated by below formula:

$(W_2-W_1)\times 100/(t_2-t_1)$

W_1=Initial weight, W_2=final weight, and t_2-t_1=period of growth.

Sampling method was accidently. Data were analyzed with Pearson using SPSS version 16.0 for correlation between water physicochemical and ionic parameters with growth indicators in *R. frisii kutum*.

Results. Ionic parameters (Na^+, K^+, Ca^{2+} and Mg^{2+}) and some physicochemical factors are shown in Table 1.

Table 1

Ionic parameters and physicochemical factors

Variable	maximum	minimum	(Mean±S.D.)
Na (mMol L^{-1})	230	447.5	315±66.3
K (mMol L^{-1})	11.5	28.8	18.457±6.033
Ca (mg dL^{-1})	9.04	22.44	15.52±3.85
Mg (mg dL^{-1})	12.47	22.45	15.85±2.44
pH	7.26	9.85	7.72±0.62
Hardness	472	826	622.8±95.97
EC (μm cm^{-2})	1.71	9.01	2.52±1.575
Salinity (g L^{-1})	0.6	1.4	0.93±0.236

The correlation between some of physicochemical factors and ionic parameters with growth in kutum are shown in Table 2.

According to Table 2 initial weight had significant and positive correlation with salinity and water Na^+ ($P<0.05$), final weight had significant and positive correlation with growth rate ($P<0.05$), pH had significant and negative correlation with water K^+ ($P<0.01$) and had significant and positive correlation with water Na^+ and Mg^{2+} ($P<0.01$), hardness had significant and negative correlation with salinity ($P<0.01$), significant and positive correlation with water Na^+ ($P<0.01$) and significant and positive correlation with water Ca^{2+} ($P<0.05$), salinity had significant and positive correlation with water Na^+ and K^+ ($P<0.01$) and finally water K^+ had significant and positive correlation with water Na^+ ($P<0.05$).

Discussion. Obtain enough and suitable food is the most important factor in aquaculture. Variations in water quality, counteraction correlations of physicochemical factors with each other and fish high density may create widespread ranges of physiological variations in fish (Flos et al 1990).

Buttner et al (1993) reported that physicochemical parameters affect on fish growth, and they also affect on each other. In this research, significant and positive correlation was observed between hardness with final weight and growth rate. Loveson (1964) suggest that in hardness allowable domain, whatever the water be harder it is suitable for fish but out of this range fish show decrease in growth with increase in water hardness.

Table 2

Correlation between physicochemical factors and ionic parameters with growth

Variable	Initial weight (g)	Final weight (g)	Growth rate (gr/day)	PH	EC (µm/cm^2)	Hardness	Salinity gr/l)(	K (mM/l)	Na (mM/l)	Mg (mg/dl)
Final weight (g)	0.397									
Growth rate (gr/day)	-0.393	**0.699								
PH	-0.283	-0.342	0.052							
EC (µm/cm^2)	-0.043	0.064	0.342	0.125						
Hardness	0.162	0.379	0.268	-0.400	0.061					
gr/l)(Salinity	**0.699	0.494	-0.142	-0.408	0.177	*-0.621				
K(mM/l)	0.370	0.095	-0.291	*-0.627	-0.189	0.520	*0.587			
Na (mM/l)	**0.667	0.336	-0.236	*0.611	-0.283	*0.618	*0.623	**0.765		
Mg (mg/dl)	-0.373	-0.138	0.477	*0.656	-0.240	0.142	-0.275	-0.313	-0.263	
Ca (mg/dl)	0.152	0.237	0.370	-0.236	-0.052	**0.779	0.477	0.309	0.522	0.031

** Correlation is significant at the 0.01 level. * Correlation is significant at the 0.05 level.

Wurts & Durborow (1992) reported that ideal pH for fish culturing is between 7.5-9, and it was coincidence with present study.

Mg^{2+} as a cofactor has correlation with Na^+ pump activity (Pequeux 1995; Furriel et al 2000). Thus, for causing this correlation, can tell that Mg^{2+} plays a role in the normal metabolism of lipids and serving as a cofactor in a large number of enzymatic and metabolic reactions (Davis & Lawrence 1997).

Calcium and magnesium are essential in the biological processes of fish (bone and scale formation, blood clotting and other metabolic reactions). However, calcium is the most important environmental, divalent salt in fish culture water (Wurts & Durborow 1992). The presence of calcium (ionic) in culture water helps reduce the loss of other salts (e.g., sodium and potassium) from fish body fluids (i.e., blood).

Sodium and potassium are the most important salts in fish blood and are critical for normal heart, nerve and muscle function. This research has also shown that environmental calcium is required to re-absorb these lost salts. In low calcium water, fish can lose (leak) substantial quantities of sodium and potassium into the water. Body energy is used to re-absorb the lost salts.

In this research no significant correlation between K^+ and fish growth was observed that doesn't correlate with Roy et al (2007) results on *Litopenaeus vannamei*. They reported that with increasing water K^+, fish weight and growth were increased. The cause of difference in results is that, in fact shrimp is euryhaline while the kutum live in freshwater, so the value of K^+ for this fish growth will be much lower than shrimp.

Luz et al (2008) on (*Carasius auratus*) in different salinity reported that existence high salinity and ions in water cause decrease of obtain food and also food absorption ability in gold fish, as a result of that increase plasma osmolality and decrease lipid value and unsaturated fatty acid. They also told if salinity be close to blood osmotic pressure, blood metabolic sources (e.g., total lipid) increase. In this research the value of salinity was measured 0.4 to 1.4 ranges that show suitable water salinity for culturing Kutum.

Fish is buoyancy animal and has regular and intense correlation with natural (physical) and life (water) environment. Fish understand the variations of water concentration and chemical composition by its sense that influence their activity (Moeinian 2006), thus environmental condition undertake vital causing to fishes evolution (Asha & Mutia 2005).

There was significant and positive correlation ($P<0.01$) between salinity with fish initial weight. De Boec et al (2000) and Sampaio et al (2007) reported that fish has growth increasing with increase in salinity up to its requirement range. Also Imanpoor (2005) with researching on *R. frisii kutum* reported that effect of fry weight on salinity resistance was significant ($P<0.05$). Findings of these researchers were correlated with present research.

The amount of available and dissolved Oxygen for aquatics in a culture system is one of the most critical variables and should be measured constantly. If suitable amount of oxygen is not available, aquatic exposed to stress and may be could not feeding well (Stickney 2000). In this research the amount of oxygen was always above 5.9 mg L^{-1} that is suitable for this species.

The result of this research shown that environmental parameters have much efficacy on production so we should try to keep water physicochemical parameters in requirement range of kutum. Hence, according to the cited instances, knowing the suitable amount of physicochemical water parameters about any fish and determine their correlation in ponds, lead aqua culturist to better management and also further fish production.

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