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## The study of metabolic and ionic factors in the blood serum of young *Acipenser persicus* caught from Guilan coastal waters

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### Abstract

This study examines certain ionic parameters including calcium, sodium, potassium, phosphorus, and magnesium and metabolic factors such as cholesterol, total protein, albumin and osmolality in the blood serum of 34 premature wild Persian Sturgeon (*Acipenser persicus*) caught by trawl nets in the Caspian Sea (Guilan coastal waters). The fish were divided into three weight groups: (below 100gr), G2 (100-500gr) and G3 (+500gr). The results indicated statistically meaningful differences across varying weight groups in terms of magnesium, calcium potassium and phosphorus ion concentrations ( $P \leq 0.5$ ), whereas sodium ions failed to show any statistically meaningful difference ( $P \leq 0.5$ ) across groups. The first group (G1) contained higher rates of magnesium and calcium ions compared to other groups. The metabolic factors including osmolality, cholesterol and albumin showed no significant difference but the total protein in G1 was significantly higher than G2 ( $P \leq 0.5$ ) reflecting no statistical difference with other groups ( $P \geq 0.5$ ). The cholesterol and total protein concentrations in G3 were at its highest level with albumin that was at the lowest level. Based on the results obtained, it can be concluded that fish of lower than 100gr were more sensitive to their environment than those of the other groups. Thus in examining the health status of *Acipenser persicus*, the link between the ions and the metabolic factors could be considered in their growth, reproduction and regulation of osmotic pressure with a view to diagnose pathogens and upgrade sturgeon fisheries in the Caspian Sea.

**Keywords:** Caspian Sea, Persian sturgeon (*Acipenser persicus*), blood serum, metabolic factors, ionic factors

### 1. Introduction

Considering the growing trend of sturgeon aquaculture in Iran and the world and the necessity to optimize propagation and culture management and sanitary procedures it is inevitable to conduct oncologic examinations so as to boost food security and alleviate economic costs of production. Blood is highly sensitive to the changes in the body of a living organism which has been the subject of much scientific enquiry on aquatics. Thus, an understanding of the optimum range of oncologic parameters within various species might shed more lights onto investigations of physiologically- induced stresses [24]. Studies related to oncologic parameters of aquatics actually appeared in the 1980s, predominantly focusing on Cyprinid and rainbow trout (*Oncorhynchus mykiss*) [22]. In recent years however, there have been extensive research on sturgeon blood due mainly to their dwindling stocks, blood cell morphology and the interrelationship of such factors with various biological processes [21].

Several factors affect ionic and metabolic parameters causing variations in blood. The biochemical parameters of blood serum including sodium, potassium, calcium and magnesium may be good indicators of fish response to the physiological stresses caused by environmental changes. The oncologic research findings may therefore be useful in eliminating uncertainties about breeders' health, growth stages, and reproduction [22]. The physiological status of fish body is dependent upon and/or affected by many internal and external factors. A certain level of a given blood factor, normal for a species might prove abnormal for another. Indeed variations in blood parameters can reflect a fish species' response against the alterations in its environment at that particular time [31]. Anemia is the most widely detected oncologic index in finfish that is related to nutrition, age and diseases. Such a factor may well be applied as a tool in controlling case of anemia in fish farming management [27].

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The interpretation of blood indices is based on the availability of reference ions which has to be determined in healthy fish under natural condition [13]. Of the total 27 caviar fish, 5 species are native to the Caspian Sea [17]. Persian Sturgeon (*Acipenser persicus*) constitutes one of those, living in the southern coasts of the Sea [17]. *Acipenser persicus* is an ecologically and economically important species that spends bulk of its lifetime in the Sea water having a salinity rate of 10-18 mg/l and which only enters into fresh water of rivers to spawn. Examining the completion cycle in osmotic pressure during developmental stages of sturgeons is of great importance because of their ecologic diversity and ancient history, making them an extraordinary subject of comparative and physiologic enquiry aimed at resolving the propagation and culture problems [20]. Thus, considering the value and importance of sturgeons in the world from economic and environmental point of view and the physiologic significance of their oncologic studies, it is unfortunate to notice that most of the oncologic and biochemical investigations in Iran have so far, been focused on farmed sturgeons or wild spawners caught for egg stripping. In this respect, Kazemi *et al.* (2006) studied the osmosis of *Acipenser persicus* blood serum maintaining that osmotic pressure of blood serum was not related to fish sex. Mohammadi *et al.* (2012) investigated salinity fluctuations in the blood serum of juvenile *Acipenser persicus* stating that biochemical parameters of blood were liable to salinity of the environment and that ionic concentration in the blood depended upon the ion concentrations of the surrounding. In yet another research, Bahmani *et al.* (2001) examined certain blood factors of young sturgeons concluding that hematological indices tend to elevate along with increased age. In their examinations focusing on the blood serum ions of juvenile sturgeons, Asadi *et al.* (2009 and 2010) pointed that ionic concentrations of blood in such fish might be influenced by their adaptations to the fresh water. Nevertheless, there have not been any studies on wild young sturgeons here in Iran specifically focusing on oncologic aspects. Thus the lack of sufficient evidence that could provide a clear picture of their basic blood pattern was the reason for conducting the present research with a view to examine the metabolic factors and blood serum of wild young *Acipenser persicus* caught from the southern Caspian Sea off Guilan shores.

## 2. Materials and Methods

In this research, 34 wild Persian Sturgeon (*Acipenser*

*persicus*) were of coastal waters of Guilan province caught using trawl method [18]. Upon blood sampling, the blood serums obtained, were placed in three weight groups; 1(G1)-(below 100gr with average  $38 \pm 13$ ), groups 2(G2)-(100-500gr, with average  $249.9 \pm 66.5$ ) and groups 3(G3)-(+500gr, with average  $1033.3 \pm 638.35$ ) and kept in fridge under  $-20^{\circ}\text{C}$  followed by implementation of biochemical tests including colorimetric measurement on biochemical blood parameters such as calcium, phosphor, magnesium ions, cholesterol, albumin and total protein by spectro-photometry equipment (UV/VIS 6505 – Jenway- Britain) and PARS test kit- (made in Iran) while Flame photometry (Corning-480 Jenway Ltd, Britain) was focused on sodium and potassium ions. In addition blood serum osmolality was determined through the use of osmometer (model 13Type. Nr.9610003–made by Rebling Co, Germany) Upon data recording aimed at cross examination, the obtained data were then analyzed, using SPSS, ONE –WAY ANOVA and Tukey test to identify the significance of differences at ( $P \leq 0.5$ ) using Excel software for the diagramming.

## 3. Results

Based on the results presented in table 1, the measured sodium ion concentrations in group 2 (G2) were higher than (G1) and (G3) and also the calcium, magnesium and osmolality in G1 stood higher than other groups. The results of statistical parameter analysis of blood serum ions showed a significant difference in G1 magnesium and calcium ion concentrations in comparison to G2 and G3 ( $P \leq 0.5$ ) whereas they failed to show any meaningful difference between G2 and G3 ( $P \geq 0.5$ ). However, sodium ions did not show any statistically significant values across different groups ( $P \geq 0.5$ ). In addition, the results related to potassium and phosphor ions indicated that Potassium ions of G1 were statistically different from those of G2 and similarly phosphor ions in G3 showed statistically different with those of G1 and G2 ( $P \leq 0.5$ ). There was also no statistically meaningful difference in terms of Potassium and phosphor ions in various groups ( $P \geq 0.5$ ).

The statistical analysis on cholesterol, albumin and osmolality revealed no significant values for these blood factors across different weight categories ( $P \geq 0.5$ ) but total protein in G3 turned to be of statistical difference with G1 showing no meaningful difference with the rest of groups ( $P \leq 0.5$ ).

**Table 1:** Biochemical parameters (Mean± Standard Deviation) and the measured range of the premature Sturgeons caught in Guilan coastal waters (n=34)

Blood factor /Weight group	G1 (-100gr)	G2 (100-500gr)	G3 (+500gr)
Magnesium (mg per deciliter)	$19.8 \pm 3.7^{\text{a}}$ (27.3-3)	$3.6 \pm 0.4^{\text{b}}$ (2.3-6.2)	$2.2 \pm 0.02^{\text{b}}$ (2.2-2.1)
calcium (mg per deciliter)	$19.2 \pm 9.7^{\text{a}}$ (6/3-32)	$9.4 \pm 2^{\text{b}}$ (7.8-13.4)	$7.6 \pm 0.6^{\text{b}}$ (7.1-8.1)
Sodium (mg per deciliter)	$140 \pm 6.8$ (135.4-151)	$141.3 \pm 4.9$ (133-146)	$138.7 \pm 7.7$ (131-148)
Potassium (mg per deciliter)	$6.6 \pm 2.2^{\text{a}}$ (4.6-9.4)	$4.6 \pm 1.2^{\text{b}}$ (3.2-6.5)	$4.8 \pm 0.9^{\text{ab}}$ (3.9-5.9)
Phosphor (mg per deciliter)	$14.7 \pm 1.4^{\text{b}}$ (6/3-32)	$14.5 \pm 5.4$ (4.8-20.4)	$22.2 \pm 1.4^{\text{a}}$ (20.5-23.7)
Cholesterol (mg per deciliter)	$60.4 \pm 39.3$ (19-115)	$176 \pm 62.6$ (65-639.6)	$113.9 \pm 58.4$ (67.3-188.5)
Total Protein (mg per deciliter)	$1.8 \pm 0.2^{\text{b}}$ (1.7-2.1)	$2.5 \pm 1.5^{\text{ab}}$ (1.5-5.6)	$3.6 \pm 0.8^{\text{a}}$ (2.5-4.3)
Albumin (mg per deciliter)	$1.2 \pm 0.7^{\text{a}}$ (0.6-1.9)	$0.75 \pm 0.2$ (0.5-1.1)	$0.9 \pm 0.4$ (0.5-1.4)
Osmolality (mg Osmo/l)	$351.7 \pm 9$ (342-365)	$347.1 \pm 24.6$ (297-376)	$332 \pm 27.9$ (296-352)

**Note:** The identical letters signify no difference but the non-identical ones are different from one another

## 4. Discussion

Comparing the data related to biochemical aspects of blood and blood factors within different sturgeon groups as well as

between sturgeons and other fish species are by no means, easy because of their species-specific physiology and biochemical characteristics and more specifically their blood

that is highly liable to environmental changes, variations within species, the type of fishing and sampling methods used, nutritional status, age, developmental stage, salinity and water temperature (10; 19). The results provided observable statistical variations across weight groups in terms of certain parameters such as magnesium, calcium and total protein ( $P \leq 0.5$ ) but sodium, cholesterol and albumin showed no significant differences in different weight categories (Table 1) The results obtained in this study and those of other research concerning biochemical parameters of most sturgeon's marine fish and fresh water species are provided in Tables 2 and 3. Nevertheless, the natural limits of key biochemical variables have so far remained unidentified for a number of species under culture conditions [11]. Studies show that sturgeons are capable of adjusting osmotic pressure and ionic concentrations of blood serum. The decline in osmotic pressure and ionic concentrations of blood serum in Caspian Sea sturgeons have clearly been shown and reported by (3; 4; 6; 7; 20), in white sturgeons by (32), in paddle fish (23;28), in Adriatic sturgeons (13; 15) and in Persian Sturgeon *Acipenser persicus* (Hallajian *et al.*, present research). In the present

research, osmotic pressure showed a downward trend from lower weight group to higher weights with a similar decline in ionic sodium, calcium and magnesium concentrations moving from lower to higher weight groups (Table 1). Such a decline in osmotic pressure occurs in line with the decrease in certain ionic concentrations within the living environment of fish [20]. In addition, research also show that ecological condition cannot, on its own determine the osmotic pressure of sturgeon blood serum. In fact, Beluga, Acetra and Sevruga (the three main Sturgeon species) possess varying osmotic pressures and ionic concentrations in their blood serum in spite of dwelling in nearly identical environmental condition [20]. As shown in Table 2 and 3, the mean osmotic pressure and ionic concentrations of potassium, sodium, calcium and magnesium in blood serum of *A. persicus* caught in coastal Guilan waters for propagation purpose were 30.29 msmol/l, 2.25 meq/l, 151.18 meq/l, 2.3 g/decilit and 1.48 meq/l [20]. The total calcium, magnesium and phosphor ions measured in the blood serum of netted premature *A. persicus* ranged from 2.1-32 mg/deciliter within the three weight groups. Total protein and albumin varied from 0.5 to 5.5 g/ deciliter.

**Table 2:** shows the measured rates of blood parameters in sturgeon serum

Biochemical parameters	species	values	references
magnesium	<i>Acipenser persicus</i> 1 and 2 years farmed	0.7 $\pm$ 0.15 meq/l	20
	Marine <i>Acipenser persicus</i>	2.77-2.95 mol/l	4
	Farmed <i>Huso huso</i>	1.8-2.16 mg/l	26
	<i>A. persicus</i> breeders caught from the Sea	1.5 mgr/deciliter	7
	Paddle fish	0.66-0.95 mmol/l	23
	Young wild <i>Acipenser persicus</i>	2.1-27.3 mgr/deciliter	Hallajian <i>et al.</i> , (Present research)
calcium	<i>Acipenser persicus</i> 1 and 2 years farmed	1.46 $\pm$ 0.3434 mg/deciliter	20
	Adriatic sturgeon	2.15-2.53 mmol/l	15
	Marine <i>Acipenser persicus</i>	1.97-2.38 mmol/l	4
	Farmed <i>Huso huso</i>	7.65-8.35 mmol/deciliter	26
	White sturgeon	1.8-4 mmol/deciliter	32
	<i>A. persicus</i> breeders caught from the Sea	1.5 mgr/deciliter	7
	paddle fish	0.66-0.95 mmol/l	23
	Young wild <i>Acipenser persicus</i>	2.1-27.3 mg/deciliter-	Hallajian <i>et al.</i> , (Present research)
sodium	<i>Acipenser persicus</i> 1 and 2 years farmed	131.7 $\pm$ 4.12 meq/l	20
	Wild male paddle fish sturgeon	151 meq/l	28
	Wild Female paddle fish	148 meq/	28
	Adriatic sturgeon	143.5-144.1 mmol/l	13
	Adriatic sturgeon	129-141 mmol/l	15
	Farmed 4 year old <i>A. Persicus</i>	152.8 mmol/l	6
	Farmed 4 year old male <i>A. Persicus</i>	156.38 mmol/l	6
	Young wild <i>Acipenser persicus</i>	131-151 meq/l	Hallajian <i>et al.</i> , (Present research)
potassium	Wild <i>Acipenser persicus</i> breeder	2.65 $\pm$ 0.9 meq/l	20
	Male wild paddle fish	2.2 meq/l	28
	female wild paddle fish	3.8 meq/l	28
	Adriatic sturgeon	3.1-3.4 mmol/l	13
	Farmed 4 year old <i>A. Persicus</i>	2.27 mmol/l	6
	Farmed 4 year old male <i>A. Persicus</i>	2.64 mmol/l	6
	Young wild <i>Acipenser persicus</i>	3.2-9.4 meq/l	Hallajian <i>et al.</i> , (Present research)
phosphor	Farmed 3 years old lake sturgeon	2.6 mgr /deciliters	28
	wild 3 years old lake sturgeon	3.2.6 mgr/deciliters	28
	Farmed <i>Huso huso</i>	2.18-2.9 mmol/l	3
	Young wild <i>Acipenser persicus</i>	4.8-23.7 mgr/deciliters	Hallajian <i>et al.</i> , (Present research)

In this study, the calcium, magnesium and phosphor ions in the blood serum of *A. persicus* stood higher than those of in the reared *A. persicus* [20] and Beluga sturgeon (*Huso huso*) [26]. The ion concentrations of calcium and magnesium in G1 (lower than 100gr) proved higher than other groups, but the phosphor ions in G3 (higher than 500gr) were higher than others while sodium and potassium ion concentrations in the

blood serum were parallel to the concentrations obtained for other sturgeons (Table 2). These ions play varied physiologic functions in the body of fish securing permeability of cell membranes. The distribution of such ions both within and outside cells to control osmotic balance is associated with hydro ionic exchanges. The permeability of sodium and chloride ions within the marine fish bones is made possible by

chloride cells in the gills. Such fish manage to keep their balance through swallowing sea water that is associated with absorption of calcium and magnesium ions in intestines.

Comparison of sturgeon's blood serum calcium and magnesium ions suggests a self-regulation of such ions by the fish (20).

**Table 3:** Shows the measured rates of metabolic parameters in sturgeon blood serum

biochemical parameters	species	Concentrations	sources
Cholesterol	2 years old wild <i>Acipenser persicus</i>	3.04 mmol/l	5
	2 years old wild <i>Acipenser stellatus</i>	3.55 mmol/l	5
	<i>Acipenser stellatus</i> breeders caught from the Sea	1.07 gr/deciliter	7
	55 gr Amur sturgeon	3.84 mmol/l	29
	45 gr Chinese sturgeon	1.64 mmol/l	29
	Short nose sturgeon	1.09 mmol/l	23
	Paddle fish	2.29 mmol/l	12
Total protein	Young wild <i>Acipenser persicus</i>	19-639.6 gr/deciliter	Hallajian <i>et al.</i> , (Present research)
	Farmed <i>Huso huso</i> (95gr)	1.5 gr/deciliter	30
	Amur sturgeon (55gr)	25.19 gr/l	29
	Chinese sturgeon (45gr)	17.82 gr/l	29
	Farmed Siberian sturgeon (26gr)	1.89 gr/deciliter	16
	2 years old wild <i>Acipenser persicus</i>	32.22 gr/l	5
	2 years old wild <i>Acipenser stellatus</i>	27.78 gr/l	5
Albumin	Young wild <i>Acipenser persicus</i>	1.5-5.6 gr/deciliter	Hallajian <i>et al.</i> , (Present research)
	Farmed <i>Huso huso</i> (95gr)	0.6 gr/deciliter	30
	Farmed Siberian sturgeon (26gr)	0.06 gr/deciliter	16
	2 years old wild <i>Acipenser persicus</i>	7.25 gr/l	5
	2 years old wild <i>Acipenser stellatus</i>	6.85 gr/l	5
Osmolarity	Young wild <i>Acipenser persicus</i>	0.5-1.3 gr/deciliter	Hallajian <i>et al.</i> (Present research)
	Farmed 1 year old <i>Acipenser persicus</i>	256.8±9.23 msmo/l	22
	Farmed 2 year old <i>Acipenser persicus</i>	261.62±7.85 msmo/l	20
	Marine <i>Acipenser persicus</i> breeders	305.29±14.33 msmo/l	20
	Young wild <i>Acipenser persicus</i>	296.-376 msmo/l	Hallajian <i>et al.</i> , (Present research)

Cholesterol partially forms cell wall structure and is a precursor of bile and steroid hormones. The cholesterol values obtained in here are well above the values reported by earlier researchers: (Table 3). The decrease in cholesterol level may suggest increased physiological unease (stress) and a metabolic lipid disorder particularly among breeders. The detected total protein and albumin concentrations in the blood serum of Persian sturgeon (*A. persicus*) were lower than those recorded for Chinese sturgeon and Amur sturgeon [26] as well as 2 years old wild *A. persicus* and two years old wild sevruga sturgeon [5] but stood higher than those in the reared Beluga sturgeon (*Huso huso*) [30] and farmed Siberian sturgeon [20], *A. brevirostrum*, *A. oxyrinchus* [9]. In addition, the osmolality rate of wild premature *A. persicus* was similar to osmotic pressure of wild marine sturgeons but dissimilar to that of fresh water fish (Table 3). The protein content of plasma tends to boost metabolic function in fish body via diminishing the volume of plasma. Therefore, stresses or prolonged hunger periods may lead to heightened protein level of plasma.

In examining the regulatory functions of osmotic pressure among *A. persicus*, researchers detected meaningfully different concentrations of blood ions indicating that only sodium and potassium ions were of higher concentrations than those in the water. Ions of magnesium and calcium were lower in ambient water [2]. The results of study on osmotic system of *A. persicus* released in river showed significant difference among ionic concentrations in the blood of such fish [2]. The blood ion measurements of juvenile *A. medirostris* at varying salinity rates revealed ionic decline in brackish water (10ppt) as compared with salty water (33 ppt) [1]. The salinity rate of the Caspian Sea water is also around 10ppt, supporting the results of the present study.

Das (1964), indicated the rise of total protein level and certain

other blood factors with increase in fish which is similar to the finding of the present study. In order to preserve the relative stability in their blood serum osmolarty, Sturgeons possess special mechanism to discharge extra ions from their blood which functions somehow differently from the rest of bony fishes (20). These includes elimination of considerable amount of sodium and calcium through kidneys (20). Based on this, the results of ionic and metabolic parameters measurements in the blood serum of *A. persicus* indicated that certain parameters decrease along with an increase in fish weight (i.e. Calcium and magnesium) whereas other parameters like phosphor, cholesterol and total protein begin to increase as bodily weight increase. The measured values pertaining to biochemical and metabolic parameters of blood serum reveal that similar to other sturgeon species, *A. persicus* adapt themselves to the brackish water of the Caspian Sea and adjust their internal osmotic pressure with external environment (i.e. hypo-somatic) via ionic changes.

## 5. Conclusion

In general, it may be stated that certain parameters in the blood serum of wild Persian Sturgeon (*Acipenser persicus*) are liable to variations as a result of factors including fish age, sex, water temperature, salinity, seasonal fluctuations and feeding status. These data might be used by fisheries researchers and aqua culturists as part of an established data base on Sturgeon's natural biochemical characteristics in general and the weight category examined here in particular and could also be used for comparison in reared sturgeons.

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