Researches Concerning Reference Values Assessment of Serum Biochemical Parameters in some Fish Species from *Acipenseridae, Cyprinidae, Esocidae and Salmonidae* Family

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Abstract

The purpose of this work was to assess reference values of serum biochemical indices (enzymes, metabolites and minerals) in some representative fish species belonging to *Acipenseridae, Cyprinidae, Esocidae and Salmonidae* family in order to establish a baseline data which will serve to monitoring nutritional-metabolic balance and healthy condition of these species from aquatic biocenosis or intensive exploitations. Serum samples were analyzed for glucose, total proteins, albumine, urea nitrogen, creatinine, uric acid, triglycerides, cholesterol, ALT, AST, GGT, alkaline phosphatase, amylase, total bilirubin, Ca, P, Mg, Fe, using a FullyVet automated chemical analyser. The obtained results were compared with those from other papers regarding serum biochemical profile of fresh water fish species. Serum biochemical reference intervals were as follows: glucose, 28.41±0.80–64.00±1.41 mgdL^{-1}; total proteins, 2.78±0.21-4.05±0.20 gdL^{-1}; albumine, 0.67±0.12–1.59±0.11 gdL^{-1}; urea nitrogen, 12.16±0.78–18.30±0.27 mgdL^{-1}; creatinine, 0.06±0.01–0.27±0.00 mgdL^{-1}; uric acid, 1.00±0.00–1.66±0.09 mgdL^{-1}; triglycerides, 46.00±1.29–351.3±12.3 mgdL^{-1}; cholesterol, 123.00±2.12–198.00±0.91±mgdL^{-1}; ALT, 15.00±0.91–32.00±1.29 IU L^{-1}; AST, 30.00±0.91–92.00±1.47 IU L^{-1}; GGT, 4.00±0.00–6.33±0.46 IU L^{-1}; alkaline phosphatase, 60.33±1.20–109.50±3.05 IU L^{-1}; amylase, 28.08±0.93 – 36.00±0.91 IU L^{-1}; total bilirubin, 0.00±0.00–0.03±0.00 mgdL^{-1}; Ca, 7.63±0.40–12.36±0.50 mgdL^{-1}; P, 11.83±0.35-30.48±0.26 mgdL^{-1}; Mg, 1.80±0.14–3.88±0.21mgdL^{-1}; Fe, 57.60±3.48–120.00± 1.08 μgdL^{-1}. The wide intra- and interspecific variability of our data requires subsequent studies of the endo- and exogenous factors (living condition, season, age, gender, origin, breeding system, physiological and nutritional status, genetic of each individual, etc.) that can induce variations of the propound parameter.

Keywords: *Acipenseridae,Cyiprinidae, Esocidae, Salmonidae* family, biochemical serum parameters

1. Introduction

Existence of an impressive baseline data regarding hematological and biochemical normal values facilitates health condition evaluation or establishment of a diagnostic in warm blooded animals (homeotherm animals) [1].

Penury data expressing normal and pathological limits of biochemical blood parameters is the main reason why blood analysis dose not participate to routine tests used for biochemical blood indices of poikilotherm animals zootechnicaly interested.

Once reference values are determined, it may enable evaluation of fish stress response, their nutritional condition, reproductive state, tissue damage due to frequent handling procedures, detection and diagnosis of metabolic disturbances or diseases processes in a fish population [2].

This study was performed to determine serum biochemical reference range of some representative species belonging to four fish family: *Acipenseridae, Cyprinidae, Esocidae, and Salmonidae*.

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2. Materials and methods

The experimental subjects (6 per each species) were collected from different locations namely:

natural habitat:
cyprinids species (carp *Cyprinus carpio*, silver crucian carp *Carassius auratus gibelio*, bream, *Abramis brama danubii*) – Gruia fish farm, Mehedinti county); esocids species (pike *Esox lucius* - Gruia fish farm, Mehedinti county);

captivity:
salmonids species (rainbow trout, *Oncorhynchus mychiss* raised in classic intensive system – Minis rainbow trout farm, Caras-Severin county and Buta rainbow trout farm, Hunedoara county); acipenserids species (siberian sturgeon *Acipenser Baerii*, starlet *Acipenser ruthenus*, russian sturgeon *Acipenser gueldenst* raised in recirculating system – Padurea Verde Didactical Station of Banat's University of Agricultural Sciences and Veterinary Medicine, Timisoara).
To reduce stress level during the blood sampling, 6 subjects belonging to each specie were rapidly netted and anesthetized with Tricaine methanesulphonate: MS – 222, 100-200 ppm concentration in water, then approximately 2 ml blood was collected by caudal venous puncture (cyprinids species) and by heart puncture (salmonids, acipenserids and esocids species) respectively.
Caudal venous puncture supposed running the following steps: inserting a needle attached to a syringe under the scales of the mid portion of the tail, just below the lateral line at a 45^{o} angle to the long axis of the fish in a cranial direction; directing the needle toward the vertebral column until reaching the base of the column; withdrawing the needle a fraction of a millimeter and obtain the blood sample; removing and discarding the needle in a sharp container [3].
Heart puncture supposed running the following steps: holding the needle attached to a syringe perpendicular to the skin and inserting the needle slightly below the tip of the V-shaped notch formed by the gills cover and the isthmus of the fish; collecting the blood as the needle enters the bulbous arteriosus; removing and discarding the needle in a sharp container [3]. After coagulation and syneresis, obtained serum was transported to the laboratory in the refrigeration conditions, where biochemical indicators: glucose, total proteins, albumine, triglycerides, cholesterol, urea nitrogen, creatinine, uric acid, alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, amylase, total bilirubin, calcium, phosphorus, magnesium, iron, were determined on an automated system, FullyVet automated chemistry analyzer, Biochemical Systems International, Arezzo, Italy, using comercial kits (Biocon ®Diagnosemittel GmbH & Co., Germany).
A nonparametric Mann-Whitney MINITAB 14 test was used for statistical analysis of data.

3. Results and discussion

The obtained results are shown in table 1-5.
Table data regarding glicemia level show evident differences between all species belonging to the four studied families, the most important ($p<0.001$) being that signalized between cyprinids (71.80 ± 1.36 mg dL^{-1}) and acipenserids (28.41 ± 0.80 mg dL^{-1}).
In case of proteinemia, except cyprinds (4.05 ± 0.20 g dL^{-1}) and acipenserids (2.78 ± 0.21 g dL^{-1}) species between that distinct significant differences at $p<0.01$ have established, the level of this serum indices has very close values translating by insignificant differences ($p>0.05$) between other compared families.
As regards albuminemia, significant differences ($p<0.001$) are maintaining between cyprinids (1.59 ± 0.11 g dL^{-1}) and acipenserids (0.81 ± 0.07 g dL^{-1}); additionally, significant differences at $p<0.001$ arise between cyprinids (1.59 ± 0.11 g dL^{-1}) and esocids (0.67 ± 0.12 g dL^{-1}).
Instead, blood urea nitrogen registered values that determined significant differences between salmonids and the rest of the species related to them: $p<0.01$ between salmonids (18.30 ± 0.27 mg dL^{-1}) and cyprinids (12.16 ± 0.78 mg dL^{-1}) and between salmonids (18.30 ± 0.27 mg dL^{-1}) and acipenserids (12.60 ± 0.81 mg dL^{-1}) respectively and $p<0.05$ between salmonids (18.30 ± 0.27 mg dL^{-1}) and esocids (12.70 ± 0.42 mg dL^{-1}).
Statistical analysis of the serum uric acid values emphasized non significant differences ($p>0.05$) between cyprinids (1.51 ± 0.10 mg dL^{-1}) and esocids (1.20 ± 0.14 mg dL^{-1}), respectively between cyprinids (1.51 ± 0.10 mg dL^{-1}) and acipenserids (1.66 ± 0.09 mg dL^{-1}); the same situation is valid for esocids (1.20 ± 0.14 mg dL^{-1}) and salmonids

(1.00±0.00 mg/dl). But for the same parameter we found significant differences ($p<0.05$) when acipenserids species (1.66±0.09 mg dL^{-1}) were compared with salmonids (1.00±0.00 mg dL^{-1}) and esocids (1.20±0.14 mg dL^{-1}).

Creatinine levels show significant differences between esocids (0.27±0.00 mg dL^{-1}) and the other three families respectively: cyprinids (0.14±0.01 mg dL^{-1}) at $p<0.05$, acipenserids (0.06±0.01 mg dL^{-1}) at $p<0.01$ and salmonids (0.13±0.02 mg dL^{-1}) at $p<0.05$ and non significant differences ($p>0.05$) between salmonids (0.13±0.02 mg dL^{-1}) and cyprinids (0.14±0.01mg dL^{-1}) and between salmonids and acipenserids (0.06±0.01 mg dL^{-1}) respectively.

Table 1. Biochemical serum parameters values in acipenserids

	Obtained values		Statistic indices		
Assessed serum parameters	Minimum values	Maximum values	x±Sx	S	Cv
Glucose (mg dL^{-1})	25	33	28.41±0.80	2.77	9.78
Total proteins (g dL^{-1})	1.77	4.00	2.78±0.21	0.75	27.11
Albumine (g dL^{-1})	0.45	1.12	0.81±0.07	0.26	32.56
Urea nitrogen (mg dL^{-1})	9.8	17.5	12.60±0.81	3.17	25.16
Uric acid (mg dL^{-1})	1	2.2	1.66±0.09	0.32	19.71
Creatinine (mg dL^{-1})	0.02	0.17	0.06±0.01	0.04	67.26
Triglycerids (mg dL^{-1})	317	412	351.3±12.3	42.7	12.16
Cholesterol (mg dL^{-1})	99	263	190.9±18.7	64.7	33.87
Total bilirubin (mg dL^{-1})	0.00	0.1	0.03±0.008	0.02	87.07
Alanine aminotransferase ALT (IU L^{-1})	9	27	19.00±1.68	5.83	30.69
Aspartate aminotransferase AST (IU L^{-1})	41	100	74.00±7.19	24.92	33.67
Gamma-glutamyltransferase (IU L^{-1})	4	9	6.33±0.46	1.61	25.49
Alkaline phosphatase (IU L^{-1})	95	122	109.50±3.05	10.55	9.64
Amylase (IU L^{-1})	23	33	28.08±0.93	3.23	11.51
Calcium (mg dL^{-1})	6.54	9.42	7.98±0.26	0.92	11.52
Phosphorus (mg dL^{-1})	10.61	16.78	12.72±0.66	2.29	18.06
Magnesium (mg dL^{-1})	1.5	2.9	2.06±0.12	0.44	21.38
Iron (μg dL^{-1})	65	142	105.67±8.82	30.55	28.91

For the two serum lipid constituents - triglycerides had significant differences between all compared species, especially between acipenserids (351.3±12.3 mg dL^{-1}) and esocids (46.00±1.29 mg dL^{-1}) ($p<0.001$) while serum cholesterol had non significant differences, except esocids (123.00±2.12 mg dL^{-1}) and salmonids (198.00±0.91 mg dL^{-1}) at $p<0.05$.

AST levels have displayed significant differences between species, the most evident beeing those between esocids (92.00±1.47 IU L^{-1}) and salmonids (30.00±0.91 IU L^{-1}) ($p<0.001$). Esocids and acipenserids ($p>0.05$) are an exception for this parameter.

Heaving the highest serum value measured to salmonids (32.00±1.29 IU L^{-1}), ALT transaminase manifested significant differences between these ones and the other three families: $p<0.01$ when salmonids are compared with acipenserids and cyprinids and $p<0.05$ when they are compared with esocids.

GGT serum values show significant differences ($p<0.01$) between acipenserids (6.33±0.46 IU L^{-1}) and cyprinids (4.60±0.24 IU L^{-1}) and between acipenserids (6.33±0.46 IU L^{-1}) and salmonids (4.00±0.00 IU L^{-1}) as well, significant differences lacking between other possible variants for compare.

Table 2. Biochemical serum parameters values in cyprinids

Assessed serum parameters	Obtained values		Statistic indices		
	Minimum values	Maximum values	x±Sx	S	Cv
Glucose (mg dL^{-1})	63	86	71.80±1.36	6.08	8.47
Total proteins (g dL^{-1})	2.1	5.76	4.05±0.20	0.93	23.11
Albumine (g dL^{-1})	0.53	2.20	1.59±0.11	0.50	31.85
Urea nitrogen (mg dL^{-1})	8.0	17.8	12.16±0.78	3.52	29.00
Uric acid (mg dL^{-1})	0.78	2.2	1.51±0.10	0.46	30.96
Creatinine (mg dL^{-1})	0.03	0.29	0.14±0.01	0.08	56.00
Triglycerids (mg dL^{-1})	68	200	141.8±10,3	46.1	32.53
Cholesterol (mg dL^{-1})	65	264	186.0±16.3	73.0	39.24
Total bilirubin (mg dL^{-1})	0.00	0.03	0.002±0.001	0.007	286.54
Alanine aminotransferase ALT (IU L^{-1})	9	23	15.40±1.04	4.67	30.34
Aspartate aminotransferase AST (IU L^{-1})	26	54	38.80±1.88	8.40	21.65
Gamma-glutamyltransferase (IU L^{-1})	4	8	4.60±0.24	1.09	23.81
Alkaline phosphatase (IU L^{-1})	46	83	60.70±2.59	11.57	19.06
Amylase (IU L^{-1})	13	56	28.95±3.50	15.66	54.08
Calcium (mg dL^{-1})	11.84	12.1	11.98±0.05	0.10	0.89
Phosphorus (mg dL^{-1})	10.00	24.90	18.05±1.08	4.82	26.73
Magnesium (mg dL^{-1})	2.0	4.8	3.88±0.21	0.97	25.04
Iron (μg dL^{-1})	41	87	57.60±3.48	15.55	27.00

Similarly to the previous situation, alkaline phosphatase had the highest mean value to acipenserids (109.50±3.05 IU L^{-1}), while its founded values in the other species and compared with those of the acipenserids leading to the significant differences between them: $p<0.001$ acipenserids-cyprinids, $p<0.05$ acipenserids-esocids and $p<0.01$ acipenserids-salmonids. There are non significant differences between cyprinids, esocids and salmonids for the considered parameter.

Esocids and salmonids who have the same mean values of serum amylase (36.00±0.91 IU L^{-1}) do not show significant differences ($p>0.05$), but these differences become distinct significant and significant respectively related to acipenserids (28.08±0.93 IU L^{-1}) ($p<0.01$) and cyprinids (28.95±3.50 IU L^{-1}) ($p<0.05$) respectively.

Serum mean value of total bilirubin in esocids was 0 and this was reason why species of these families could not be compared with none of studied species. Instead non significant differences ($p>0.05$) were found between acipenserids and salmonids and the both of them had significant ($p<0.05$) and very significant difference ($p<0.001$) respectively when they were compared with cyprinids.

The lowest values of serum iron were found in cyprinids (57.60±3.48 (μg dL^{-1}l), and the highest ones in salmonids (120.00±1.08 (μg dL^{-1}); Significant difference arise between cyprinids and the rest of species, especially in cyprinids-salmonids ($p<0.001$) variant and cyprinids-acipenserids ($p<0.01$) variant and between esocids and salmonids ($p<0.05$) as well.

Cyprinids and salmonids presented very close values of serum calcemia (11.98±0.05 mg dL^{-1} and 12.36±0.50 mg dL^{-1} respectively), reason why diffrence between them proved to be insignificant. Similarly it can be described comparation between esocids (7.63±0.40 mg dL^{-1}) and acipenserids (7.98±0.26 mg dL^{-1}). Differences were distinct significants at $p<0.01$ instead between salmonids and acipenserids ranging until very significant difference $p<0.001$) when salmonids were compared with esocids.

Magnesium had the highest value of its serum level in cyprinids (3.88±0.21 mg dL^{-1}) and leading

Table 3. Biochemical serum parameters values in esocids

Assessed serum parameters	Obtained values		Statistic indices		
	Minimum values	Maximum values	x±Sx	S	Cv
Glucose (mg dL^{-1})	30	38	34.00±1.83	3.65	10.74
Total proteins (g dL^{-1})	3.15	3.60	3.30±0,10	0.21	6.36
Albumine (g dL^{-1})	0.42	1.00	0.67±0.12	0.25	37.64
Urea nitrogen (mg dL^{-1})	11.9	13.7	12.70±0.42	0.84	6.68
Uric acid (mg dL^{-1})	1.0	1.6	1.20±0.14	0.28	23.57
Creatinine (mg dL^{-1})	0.25	0.29	0.27±0.008	0.01	6.05
Triglycerids (mg dL^{-1})	43	49	46.00±1.29	2.58	5.61
Cholesterol (mg dL^{-1})	119	128	123.00±2.12	4.24	3.45
Total bilirubin (mg dL^{-1})	0.00	0.00	0.00±0.00	0.00	-
Alanine aminotransferase ALT (IU L^{-1})	13	17	15.00±0.91	1.82	12.17
Aspartate aminotransferase AST (IU L^{-1})	89	95	92.00±1.47	2.94	3.20
Gamma-glutamyltransferase (IU L^{-1})	4	6	5.00±0.40	0.81	16.33
Alkaline phosphatase (IU L^{-1})	58	62	60.33±1.20	2.08	3.45
Amylase (IU L^{-1})	34	38	36.00±0.91	1.82	5.07
Calcium (mg dL^{-1})	7.00	8.72	7.63±0.40	0.81	10.73
Phosphorus (mg dL^{-1})	11.00	12.73	11.83±0.35	0.70	5.98
Magnesium (mg dL^{-1})	1.5	2.11	1.80±0.14	0.29	16.36
Iron (μg dL^{-1})	41	87	84.00±0.70	1.41	1.68

Table 4. Biochemical serum parameters values in salmonids

Assessed serum parameters	Obtained values		Statistic indices		
	Minimum values	Maximum values	x±Sx	S	Cv
Glucose (mg dL^{-1})	62	68	64.00±1.41	2.83	4.42
Total proteins (g dL^{-1})	2.71	3.80	3.26±0.22	0.44	13.78
Albumine (g dL^{-1})	0.62	1.52	1.17±0.19	0.38	32.98
Urea nitrogen (mg dL^{-1})	17.6	18.9	18.30±0.27	0.54	2.99
Uric acid (mg dL^{-1})	1.0	1.0	1.00±0.00	0.00	0.00
Creatinine (mg dL^{-1})	0.07	0.20	0.13±0.02	0.05	43.97
Triglycerids (mg dL^{-1})	238	244	241.00±1.29	2.58	1.07
Cholesterol (mg dL^{-1})	196	200	198.00±0.91	1.83	0.92
Total bilirubin (mg dL^{-1})	0.00	0.1	0.05±0,02	0.04	81.65
Alanine aminotransferase ALT (IU L^{-1})	29	35	32.00±1.29	2.58	8.07
Aspartate aminotransferase AST (IU L^{-1})	28	32	30.00±0,91	1.82	6.09
Gamma-glutamyltransferase (IU L^{-1})	4	4	4.00±0.00	0.00	0.00
Alkaline phosphatase (IU L^{-1})	68	72	70.00±0.91	1.82	2.61
Amylase (IU L^{-1})	34	38	36.00±0.91	1.82	5.07
Calcium (mg dL^{-1})	8.46	18.83	12.36±0.50	2.26	18.33
Phosphorus (mg dL^{-1})	30.02	31.21	30.48±0.26	0.53	1.75
Magnesium (mg dL^{-1})	2.5	3	2.80±0.12	0.24	8.75
Iron (μg dL^{-1})	118	123	120.00±1.08	2.16	1.80

to distinct singnificant differences ($p<0.01$) when cyprinids were compared with acipenserids (2.06±0.12 mg dL^{-1}) and very significant differences when cyprinids were compared with esocids (1.80±0.14 mg dL^{-1}). Significant differences were obtained as well when salmonids

(2.80±0.12 mg dL^{-1}) were compared with esocids (1.80±0.14 mg dL^{-1}) and acipenserids (2.06±0.12 mg dL^{-1}). But no significant differences were found for esocids-acipenserids, as we will see further about phosphoremia.

Again, salmonids have the highest serum values for a given parameter (30.48±0.26 mg dL^{-1}) whence significant difference resulting from their comparation with all rest of species. An other difference, distinct singnificant ($p<0.01$) arise when cyprinids (18.05±1.08 mg dL^{-1}) are compared with esocids (11.83±0.35 mg dL^{-1}) and acipenserids (12.72±0.66 mg dL^{-1}).

Large variations of blood parameters obtained by us may be due to the interspecific variability, environment conditions (natural habitat or captivity, water temperature and chemistry, deep of water source), season, physiological and nutritional status of the tested specimens. Previous studies performed by Jirasek et al., (1998) [4], Hrubec et al., (2000) [5], Svetina et al., (2002) [6], Chen et al., (2003) [7], Mensinger (2005) [8], Aras et al., (2008) [9] lend support to our finding.

Table 5. Statistical significance

Glucose	Acipenseridae	Salmonidae	Esocidae	**Proteins**	Acipenseridae	Salmonidae	Esocidae
Ciprinidae	***	*	**	Ciprinidae	**	NS	NS
Esocidae	*	*		Esocidae	NS	NS	
Salmonidae	**			Salmonidae	NS		
Albumine	Acipenseridae	Salmonidae	Esocidae	**Urea**	Acipenseridae	Salmonidae	Esocidae
Ciprinidae	***	NS	**	Ciprinidae	NS	**	NS
Esocidae	NS	NS		Esocidae	NS	*	
Salmonidae	NS			Salmonidae	**		
Uric acid	Acipenseridae	Salmonidae	Esocidae	**Creatinine**	Acipenseridae	Salmonidae	Esocidae
Ciprinidae	NS	*	NS	Ciprinidae	**	NS	*
Esocidae	*	NS		Esocidae	**	*	
Salmonidae	*			Salmonidae	NS		
Triglycerids	Acipenseridae	Salmonidae	Esocidae	**Cholesterol**	Acipenseridae	Salmonidae	Esocidae
Ciprinidae	***	**	**	Ciprinidae	NS	NS	NS
Esocidae	**	*		Esocidae	NS	0,8852	
Salmonidae	**			Salmonidae	NS	*	
Bilirubin	Acipenseridae	Salmonidae	Esocidae	**AST**	Acipenseridae	Salmonidae	Esocidae
Ciprinidae	*	***	-	Ciprinidae	*	*	**
Esocidae	-	-		Esocidae	NS	***	
Salmonidae	NS			Salmonidae	**		
ALT	Acipenseridae	Salmonidae	Esocidae	**GGT**	Acipenseridae	Salmonidae	Esocidae
Ciprinidae	NS	**	NS	Ciprinidae	**	NS	NS
Esocidae	NS	*		Esocidae	NS	NS	
Salmonidae	**			Salmonidae	**		
Phosphatase	Acipenseridae	Salmonidae	Esocidae	**Amilase**	Acipenseridae	Salmonidae	Esocidae
Ciprinidae	***	NS	NS	Ciprinidae	NS	*	*
Esocidae	**	NS		Esocidae	**	NS	
Salmonidae	**			Salmonidae	**		
Calcium	Acipenseridae	Salmonidae	Esocidae	**Phosphorus**	Acipenseridae	Salmonidae	Esocidae
Ciprinidae	**	NS	**	Ciprinidae	**	**	**
Esocidae	NS	***		Esocidae	NS	*	
Salmonidae	**			Salmonidae	**		
Magnesium	Acipenseridae	Salmonidae	Esocidae	**Iron**	Acipenseridae	Salmonidae	Esocidae
Ciprinidae	**	NS	***	Ciprinidae	**	***	*
Esocidae	NS	*		Esocidae	NS	*	
Salmonidae	*			Salmonidae	NS		

$^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$; NS - non significant differences ($p>0.05$)

As a whole, measured seric biochemical parameters of the studied fish species in our experiment behave in the manner of those reported by the mentioned authors to the fresh water fish manifesting a large variability, but ranging in the prior communicated intervals of reference.

We will summarize here, with only some additional comments:

Salmonids species had the largest values of phosphorus and almost investigated minerals in fact. Phosphorus is generally considered the most critical macromineral in fish nutrition because its availability from water may be limited. Its requirement and functions are superior to that of any other mineral element [10]. Unlike calcium, which can normally be absorbed from the water, phosphorus must be incorporated at relatively high levels in diet as fish meal (up to 48% in salmonids diet raised in intensive system) or as mineral supplement in different proportions.

Our obtained values of serum phosphorus in salmonids are close of those reported by Manera and Britti [11] in 2006.

Another serum parameter – ureea – produced by liver and excreted by gills [12] whose blood level was found especially high in Salmonidae. Commonly, in marine fish high concentrations of blood urea nitrogen are related to liver or gill diseases (diminish of gill osmoreglatory capability) while a declining blood urea nitrogen may indicate liver disease or starvation. In fresh water fish instead reference values for blood urea nitrogen range from 0.4 mg/dl in storage on to 13.5 mg/dl in *Aplodinotus grunniens* [13] while Wilson and Adolph cited by Denis W. [14] reported more large limits: from 1.1 mg/dl to 16.0 mg dL^{-1}. Hence, it seems possible that there may be a tendency for the cells of the blood as well as other cells of the body to retain urea when its concentration becomes very low.

Regarding cholesterolemia, many authors reported seasonal variations translated by decrease of its value during spawning in *Salmo trutta* [15], *Halobatrachus* [16] and reaching top levels during the prespawing period in *Leuciscus cephalus* [9]. As is known reproduction is one of the important factors affecting fish physiology. Lipid stores represent major energy reserves in fish [17], and during sexual maturation they are mobilized and directioned from previously stored tissue to gonads to sustain their development. Gonads require supplies of precursors needed for cell membrane reconstruction (phospholipids) and cholesterol as substratum for steroidogenesis. Thus we can explaine high cholesterol levels founded in all studied species less esocids.

High levels of serum tryglicerides specially measured in acipenserids and salmonids may be due to the elevated metabolic rate and to the disposable of the additional feed as a result of captivity exploitation.

4. Conclusions

Because our data showed a large intra- and interspecific variability, subsequent studies of the endo- and exogenous factors (living condition, season, age, gender, origin, breeding system, physiological and nutritional status, genetic of each individuals, etc.) who can induce variations of the propound parameter are required.

References

1. Michael, J. Manuel, Debra, L., Miller, D.V.M., Anita Merrill, Hematologic and plasma biochemical values of healty hybrid tilapia (*Oreochromis aureus* x *Oreochromis nilotica*) maintained in a recirculating system, Journal of Zoo and Wildlife Medicine, 2007, 38(3), 420-424.

2. Congleton, J. L., Wagner, T., Blood-chemistry indicators of nutritional status and food intake in juvenile salmonids, J. Fish Biol., 2006, 69, 473-490.

3. Fisheries and Oceans Canada (DFO), 2004, Blood sampling of finfish. Canada Department of Fisheries and Oceans animal-user training template, Home page address:http://www.ccac.ca/en/CCAC.../4_Blood_Sampling_of_Finfish.pdf

4. Jirasek, J., Mares, J., Palikova, M., Hematological and Biochemical Indices of blood in Wels (*Silurus glanis* L.) from intensive aquaculture, Acta Vet. Brno, 1998, 67, 227-233.

5. Hrubec, T.C., Cardinante, J. L., Smith, S.A., Hematology and serum chemistry reference intervals for cultured tilapia (*Oreochromis hybrid*), Vet.Clin. Pathol., 2000, 29, 7-12.

6. Svetina, A., Matasin, E., Tofant A., Hematology and some blood chemical parameters of young carp till the age of three years, 2002, 50(4), 459-467.

7. Chen, C.Y., Wooster, G. A, Getschell, R.G., Bowser, P. A., Timmons, M. B., Blood chemistry of healthy, nephrocalcinosis-affected and ozone-trated tilapia in a recirculating system, with application of discriminant analysis, 2003, Aquaculture 218, 89-102.

8. Allen, F. Mensinger, Blood biochemistry of the oyster toadfish, Journal of Aquatic Animal Healt, 2005, 17, 170-176.

9. Aras, M., Bayr, B., Sirkecioglu, A. N., Polat, H., Bayir, M., Seasonal variations in serum lipids, lipoproteins and some haematological parameters of chub (*Leuciscus cephalus*), Ital. J. Anim. Sci., 2008, 7, 439-448.

10. Satoh, S., Takanezawa, M., Akimoto, A., Kiron, V. and Watanabe, T., Changes of phosphorus absorption from several feed ingredients in rainbow trout during growing stages of extrusion of soybean meal. *Fish. Sci*. 2002, 68, 325–331.
11. Manera, M., Britti, D., Assessment of blood chemistry normal ranges in rainbow trout, Journal of Fish Biology, 2006, 69, 1427–1434.
12. Walsh, P.J., Mayer, G. D., Medina, M., Bernstein, M.L., Barimo, J. F., Mommsen, T.P., A second glutamine synthetase gene with expression in the gills of Gulf toarfish (*Ospanus beta*), Journal of Experimental Biology, 2003, 206, 1523-1533.
13. Wilson, D. W., Adolph, E. F. , The partition of non-protein nitrogen in the blood of fresh water fish, Journal of Biological Chemistry, 29 (3), 405-411.
14. Denis, W., The non-protein organic constituents in the blood of marine fish, J. Biol. Chem, 1922, 693-700
15. McCartney, T.H., Monthly variations of the serum total cholesterol of mature brown trout, Fisheries Research Bulletin of New York, 1966, 30, 42-45.
16. Munoz-Cueto, J. A., Alvarez, M., Blanco, M., Gonzales de Canales, M.L., Garcia-Garcia, A., Sarasquete, C., Histochemical and biochemical study of lipids during the reproductive cycle of the toad-fish, *Halobatrachus didactylus* (Schneider, 1801), Scientia Marina, 1996, 60, 289-296.
17. Wallaert, C., Babin, P. J., Age-related, sex related and seasonal changes of plasma lipoprotein concentrations in trout, J. Lipid Res., 1994, 35, 1619-1633.