**Current Trends in Natural Sciences**
Vol. 8, Issue 16, pp. 63-74, 2019
Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521
Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

# THE ACTION OF $BASO_4$ ON SOME PHYSIOLOGICAL INDICES AT *Carassius gibelio* Bloch, 1782

**Claudiu Alexandru Baciu [1*], Catalina Ciobanu [1], Alexandru Gabriel Marinescu [1]**

[1] University of Pitesti, Department of Natural Sciences, Piteşti, Romania,

***Abstract***
*Under barium exposure, significant changes in respect of oxygen consumption, respiratory rate, red blood cell count and glycaemia were recorded in the specimens of crucian carp studied being viewed as a response to the stress caused by particulate matter.*
*The interval of the non-lethal concentration of the barium at the Carassius gibelio Bloch,1782 individuals is situated between 1 – 1500 mg/l, and the lethal concentration $DL_{100}$ = 2000 mg/l. For the determination of DL 100 we used semistatic testing at 24 hours.*
*The highest variations of the physiological indices percentage-wise were seen in: glucose, whose value was in the control sample 49.33 mg/dl, and in the experimental sample, exposed to 40 mg/ l $BaSo_4$ was 87 mg/dl, representing an increase of 76.36% after 336 hours and red blood cell count where values increased significantly by 183%, 152% respectively 120.41% in concentrations of 40, 35 and 30 mg/l of $BaSO_4$.*

*Keywords: barium, concentration, exposure time, lethal dose, physiological indices*

## 1. INTRODUCTION

Water contamination by a long line of pollutants has, over the past decades, become a major problem (Canli et al., 1998; Voegborlo et al., 1999; Dirilgen, 2001, Vutukuru, 2005). Heavy metal contamination in the aquatic environment is a potential threat for aquatic organisms, when exposed to significant amounts of metals as a consequence of industrial, agricultural and anthropological activities.

Heavy metal salts (Mn, Co, Ni, Cr, As, Cd, Pb, Fe, Sn, Sb, Au, Ag, Cu, Hg) are a very serious form of pollution for surface waters due to their toxicity and stability, as they can cause disorders of the biological equilibrium having negative outcome on the self-cleaning process, fisheries economics and various uses of water. Heavy metals at high concentrations can cause harmful effects on metabolic, physiological, and biochemical systems of fishes (Yang et al., 2003) and it causes long-term eco-toxicological effects (Starmark and Braunbeck, 2000).

Fish are widely used to evaluate the health of aquatic ecosystems because pollutants build up in the food chain and are responsible for adverse effects and death in the aquatic systems (Yousuf and El-Shahawi, 1999; Farkas et al., 2002)

The lack of results regarding the changes of some certain physiological indices in the case of crucian carp under the action of $BaSo_4$ motivated us to make different researches on some


*Corresponding author, E-mail address: claudiu_alexandru88@yahoo.com

**Current Trends in Natural Sciences**
Vol. 8, Issue 16, pp. 63-74, 2019
Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521
Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

physiological parameters, such as the oxygen consumption, the breathing frequency, the number of red blood cells and the glycaemia.

## 2. MATERIALS AND METHODS

Specimens from *Carassius gibelio* Bloch, 1782 species taken from Budeasa lake weighing between 5-20 g were used in these studies.
The preparation of experimental animals was made so that prior to the experiment being conducted, an “acclimation” (Fry, 1967) to the respective temperature would take place for every sample (for 1 week) (AT=ET).
The temperature during the experiments’ carry out was 18-20$^0$C, and the lighting lasted for 8-12 hours.
Thus, potential influences from factors that were not part of that experiment’s purpose were avoided. The “negative” influence (within the meaning of a “hypometabolic” effect) of low concentrations of oxygen dissolved in water was particularly avoided, oxygen consumption being foreseen (in preliminary “optimization” measurements) not to exceed 25-30% of the total amount existing in the beginning of the experiment.
The specimens used in various experimental alternatives were selected and sorted by weight categories, with a view to avoiding or, on the contrary, emphasizing the effect of body weight’s individual factor. The specimens’ selection and making up of experimental samples were done carefully, using only healthy fish and with appropriate appearance.
To conduct the research, we made up samples of 10 specimens each as follows:
The control sample was made up of 10 specimens
1$^{st}$ sample consisted of 10 specimens exposed to $BaSO_4$ with a concentration of 30 mg/l;
2$^{nd}$ sample consisted of 10 specimens exposed to $BaSO_4$ with a concentration of 35 mg/l;
3$^{rd}$ sample consisted of 10 specimens exposed to $BaSO_4$ with a concentration of 40 mg/l.
Determination of the oxygen consumption and respiratory rate after 24, 48, 72, 96,168 and 336hours was conducted for every specimen of the 3 samples, and red blood cell count and glycaemia were measured thereafter.
The determination of oxygen consumption was made using the classical Winkler method or the confined space method Picoş and Năstăsescu (1988).
The respiratory rate measurement was made using a procedure recommended by (Pora and Nițu, 1952) during the entrapment of fish to carry out the Winkler method (Picoş and Năstăsescu, 1988); successive determination of this index were made (by using a stop-watch) until 3 close values were achieved (their arithmetic mean representing the respiratory rate at that time).
Measurement of glycaemia was made using an Accutrend GCT testing meter allowing the measurement of its value in the blood drop sampled from the caudal artery (Picoş and Năstăsescu, 1988) in a very short time-frame.
Red blood cell count was made with the help of a Thoma counting chamber by the method described by (Picoş and Năstăsescu, 1988) from blood sampled from the caudal artery.
The results obtained in experiments were interpreted in programs that Microsoft Excel and Anova LSD.

## 3. RESULTS AND DISCUSSIONS

The researches regarding the changes of some physiologic indices at the *Crucian carp* items under the action of $BaSO_4$ were stimulated not only by the lack of results in the literature, but also by the presence of barium concentrations determined in the photic zone of Cerbureni Lake from 2013 illustrated in table 1.



*Corresponding author, E-mail address: claudiu_alexandru88@yahoo.com

**Current Trends in Natural Sciences**
Vol. 8, Issue 16, pp. 63-74, 2019
Current Trends in Natural Sciences (on-line) Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-953X ISSN: 2284-9521
ISSN-L: 2284-9521 ISSN-L: 2284-9521

***Table 1. The concentration of certain heavy metals identified in the photic zone of Cerbureni Dam in 2013***
(**Source: Argeş-Vedea Water Basin Administration 2013**

| Group | Index | Measure unit | Count | Average | Min | Max | StDev |
|---|---|---|---|---|---|---|---|
| Prioritary substances- Metals | Dissolved Cadmium | µg/l | 7.000000 | 0.050000 | 0.050000 | 0.050000 | 0.000000 |
| Specific pollutans- Metals | Total Cadmium | µg/l | 7.000000 | 0.050000 | 0.050000 | 0.050000 | 0.000000 |
| Prioritary substances- Metals | Dissolved Mercury | µg/l | 6.000000 | 0.005000 | 0.005000 | 0.005000 | 0.000000 |
| Specific pollutans- Metals | Total Mercury | µg/l | 8.000000 | 0.005875 | 0.005000 | 0.012000 | 0.002475 |
| Prioritary substances- Metals | Dissolved nickel | µg/l | 8.000000 | 1.000000 | 1.000000 | 1.000000 | 0.000000 |
| Specific pollutans- Metals | Total nickel | µg/l | 7.000000 | 1.000000 | 1.000000 | 1.000000 | 0.000000 |
| Prioritary substances- Metals | Dissolved lead | µg/l | 8.000000 | 1.000000 | 1.000000 | 1.000000 | 0.000000 |
| Specific pollutans- Metals | Total lead | µg/l | 7.000000 | 1.000000 | 1.000000 | 1.000000 | 0.000000 |
| Specific pollutans- Metals | Dissolved copper | µg/l | 3.000000 | 0.250000 | 0.250000 | 0.250000 | 0.000000 |
| Specific pollutans- Metals | Total copper | µg/l | 7.000000 | 1.954285 | 0.540000 | 4.940000 | 1.561099 |
| Specific pollutans- Metals | Dissolved zinc | µg/l | 3.000000 | 25.000000 | 25.000000 | 25.000000 | 0.000000 |
| Specific pollutans- Metals | Total zinc | µg/l | 7.000000 | 25.000000 | 25.000000 | 25.000000 | 0.000000 |
| Specific pollutans- Metals | Cr total (Cr3+ + Cr6+) | µg/l | 7.000000 | 0.500000 | 0.500000 | 0.500000 | 0.000000 |
| Specific pollutans- Metals | As total | µg/l | 7.000000 | 1.500000 | 1.500000 | 1.500000 | 0.000000 |
| Specific pollutans- Metals | Total barium | µg/l | 7.000000 | 15.122571 | 7.841000 | 32.400000 | 8.884254 |
| Specific pollutans- Metals | Total Beryllium | µg/l | 7.000000 | 0.100428 | 0.050000 | 0.310000 | 0.098698 |
| Specific pollutans- Metals | Total Boron | µg/l | 7.000000 | 0.750000 | 0.750000 | 0.750000 | 0.000000 |
| Specific pollutans- Metals | Total selenium | µg/l | 7.000000 | 0.597142 | 0.525000 | 1.030000 | 0.190872 |

To notice the action of the barium sulphate on certain physiological biomarkers at the *Carassius gibelio* Bloch, 1782 items, we had to establish the lethal concentration $DL_{100}$ and the non-lethal concentrations.
The interval of the non-lethal concentrations of nickel at the *Carassius gibelio* Bloch,*1782* fluctuates between 0 – 1500 mg/l, and the lethal concentration had the value of $DL_{100}$ = 2000 mg/l . For the determination of DL 100 we used semistatic testing at 24 hours. I used aquariums with a capacity of 10-20 liters, where I introduced 10 fish adding different concentrations of substance, so that I discovered the range of sublethal concentrations and lethal doses. Based on these results, we decided to see how the three concentrations of 40, 35 and 30 mg/l modify the oxygen consumption,


*Corresponding author, E-mail address: claudiu_alexandru88@yahoo.com

**Current Trends in Natural Sciences**
Vol. 8, Issue 16, pp. 63-74, 2019
Current Trends in Natural Sciences (on-line) Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-953X ISSN: 2284-9521
ISSN-L: 2284-9521 ISSN-L: 2284-9521

the breathing frequency, the number of red blood cells and the glycaemia at the *Carassius gibelio* Bloch, 1782.
We notice from Fig. 1 that barium sulphate determines the decrease in oxygen consumption rate after all the time intervals studies. We also notice from the same chart that a more pronounced decrease in oxygen consumption rate is registered after 168 and 336 hours since administering the substance.

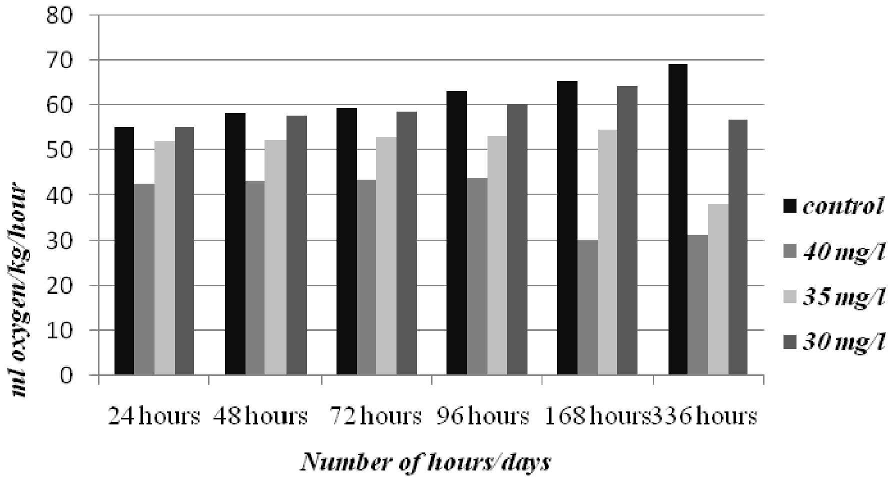


***Figure 1. Effect of barium sulphate over oxygen consumption in Carassius gibelio Bloch, 1782***

Another finding which may be drawn from analyzing this data points to the fact that the most extensive hypometabolic effect is produced by the dosage of 40 mg of $BaSo_4$ in all cases studied. The most reduced hypometabolic effect was registered in the time -frames 24, 48, 72 and 96 hours since exposure, and the most extensive was registered after 168 and 336 hours since exposure.
In addition, a decrease in oxygen consumption rate was reported by (Dobreva *et al.*, 2008) after exposing Crucian carp *Carassius gibelio Bloch,1782* to growing increase in the concentration of zinc for 96 hr.
As a short conclusion, it is noted that the greatest differences in oxygen consumption rate between the control value and the barium sulfate concentrations are seen after 336 hours, and the smallest differences after 24 hours.

***Table 2. The average variation of oxygen consumption variation to lots of Carassius gibelio Bloch, 1782 under exposure to barium sulphate at concentrations of 30, 35 and 40 mg/l water***

| | 24 hours | 48 hours | 72 hours | 96 hours | 168 hours | 336 hours | Mean value |
|---|---|---|---|---|---|---|---|
| Control | 55.302 | 58.423 | 59.601 | 63.209 | 65.568 | 69.16 | 61.87717 |
| 40 mg/l | 42.827 | 43.138 | 43.452 | 43.771 | 29.851 | 31.271 | 39.05167 |
| 35 mg/l | 52.096 | 52.497 | 52.903 | 53.315 | 54.606 | 38.243 | 50.61 |
| 30 mg/l | 55.222 | 57.83 | 58.536 | 60.365 | 64.305 | 57.016 | 58.879 |

The values of oxygen consumption rate in all concentrations in table 2 show that its highest decrease in specimens of crucian carp (31.271 ml oxygen/kg/hour) occurred after 336 hours in the presence of 40 mg/l concentration of $BaSo_4$, registering a decrease by 54.79% as compared with the oxygen consumption of the control sample (69.16 ml oxygen/kg/hour), preceded by the concentration of 35 mg/l where oxygen consumption rate (38.243 ml oxygen/kg/hour) was lower by 44.71% as compared with the control value stated above, so that in the end there is the


*Corresponding author, E-mail address: claudiu_alexandru88@yahoo.com

**Current Trends in Natural Sciences**
Vol. 8, Issue 16, pp. 63-74, 2019
Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521
Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

concentration of 30 mg/l where oxygen consumption rate(57.016 ml oxygen/kg/hour) was lower than the control value by 17.56%.

The same result was reported for the common carp by (DeBoeck et al., 1995) when they exposed fish to sub-lethal concentration of copper, and (Jezierska and Sarnowski, 2002) when they exposed *C. carpio* larvae to mercury, copper and cadmium, and reported that short-term copper exposure resulted in a strong decline of oxygen consumption by the larvae of *C. carpio* compared with cadmium.

The highest oxygen consumption rate under exposure to barium sulfate was 64.305 ml oxygen/kg/hour at a concentration of 30 mg/l after 168 hours, lower by 1.93% than the oxygen consumption rate recorded by the control sample (65.568 ml oxygen/kg/hour).

When looking at mean values of oxygen consumption rates shown in table 1, we note that the lowest mean value (39.051 ml oxygen/kg/hour) registered for the concentration of 40 mg/l of $BaSo_4$ is lower by 36.89% than the mean value of oxygen consumption in the control sample (61.877 ml oxygen/kg/hour), followed by the mean value of oxygen consumption rate(50.61 ml oxygen/kg/hour) from the concentration of 35 mg/l $BaSO_4$ which is lower by 18.21% than the mean value of the control sample aforementioned, and in the end there is the mean value of oxygen consumption rate (58.879 ml oxygen/kg/hour) from the concentration of 30 mg/l BaSo4, lower by 4.85% than the mean value of the control sample for oxygen consumption above-mentioned.

The decrease in the oxygen consumption rate may occur due to the direct action on the nervous centers and stress caused by $BaSo_4$ and it could also be attributed to the red blood cells' inability to bind to the oxygen needed by the cells and tissues making up the internal organs.

***Table 3. Multiple comparison of oxygen consumption values after 24 hours in the control sample with the oxygen consumption values of specimens of crucian carp exposed to barium sulphate in concentrations of 30 mg/l, 35 mg/l and 40 mg/l***

| | | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| (I) VAR00002 | (J) VAR00002 | | | | Lower Bound | Upper Bound |
| control | 40 | 12.7443* | 1.8754 | .000 | 8.4196 | 17.0690 |
| | 35 | 3.0700 | 1.8754 | .140 | -1.2547 | 7.3947 |
| | 30 | -.1273 | 1.8754 | .948 | -4.4520 | 4.1974 |
| 40 | control | -12.7443* | 1.8754 | .000 | -17.0690 | -8.4196 |
| | 35 | -9.6743* | 1.8754 | .001 | -13.9990 | -5.3496 |
| | 30 | -12.8717* | 1.8754 | .000 | -17.1964 | -8.5470 |
| 35 | control | -3.0700 | 1.8754 | .140 | -7.3947 | 1.2547 |
| | 40 | 9.6743* | 1.8754 | .001 | 5.3496 | 13.9990 |
| | 30 | -3.1973 | 1.8754 | .127 | -7.5220 | 1.1274 |
| 30 | control | .1273 | 1.8754 | .948 | -4.1974 | 4.4520 |
| | 40 | 12.8717* | 1.8754 | .000 | 8.5470 | 17.1964 |
| | 35 | 3.1973 | 1.8754 | .127 | -1.1274 | 7.5220 |

* The mean difference is significant at the .05 level.

The decreases in the oxygen consumption rate were also reported by (Vutukuru, 2005) in *Labeo rohita* exposed to chromium indicating the onset of acute hypoxia under metallic stress.


*Corresponding author, E-mail address: claudiu_alexandru88@yahoo.com

Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521
Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

Reduction of oxygen consumption rate in fish exposed to heavy metals indicate the onset of hypoxia under metallic stress (James, 1990), because metals accumulate in gill epithelium and induce lesions like necrosis, thickening and separation of respiratory epithelium (Peuranen et al., 1994; Hassan, 2005).

In addition, metals may impair the respiratory surface function by reducing the respiratory surface area through the atrophy and fusion of secondary lamellae, as well as the internal action of metal which enhances the action of respiratory inhibiting factors (Muthukumarvel et al., 2007); (Shereena and Logswamy, 2008).

The table above shows that values of oxygen consumption in the control sample after 24 hours are statistically significant as compared to values of oxygen consumption of specimens of crucian carp exposed to barium sulphate at a concentration of 40 mg/l $BaSO_4$, except for concentrations of 35 and 30 mg/l $BaSo_4$ where changes in oxygen consumption rate as compared to values of oxygen consumption of the control sample were not statistically significant for the significance threshold $p<0.05$. The highest mean difference in favour of the control sample with regard to oxygen consumption is 12.744 ml oxygen/kg/hour between the control sample and the concentration of 40 mg/l $BaSO_4$, followed by the mean difference of 3.070 ml/oxygen/hour registered between the concentration of 35 mg/l $BaSO_4$ and the control sample, and in the end there is the difference of 0.127 ml oxygen/kg/hour between the concentration of 30 mg/l $BaSO_4$ and the control sample in favour of the concentration of 30 mg/l.

***Table 4. Multiple comparison between oxygen consumption values after 336 hours from the control sample and oxygen consumption values of specimens of crucian carp exposed to barium sulphate in concentrations of 30 mg/l, 35 mg/l and 40 mg/l***

| | | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| (I) VAR00002 | (J) VAR00002 | | | | Lower Bound | Upper Bound |
| control | 40 | 37.8157* | 1.8741 | .000 | 33.4940 | 42.1373 |
| | 35 | 30.8283* | 1.8741 | .000 | 26.5067 | 35.1500 |
| | 30 | 12.0480* | 1.8741 | .000 | 7.7263 | 16.3697 |
| 40 | control | -37.8157* | 1.8741 | .000 | -42.1373 | -33.4940 |
| | 35 | -6.9873* | 1.8741 | .006 | -11.3090 | -2.6657 |
| | 30 | -25.7677* | 1.8741 | .000 | -30.0893 | -21.4460 |
| 35 | control | -30.8283* | 1.8741 | .000 | -35.1500 | -26.5067 |
| | 40 | 6.9873* | 1.8741 | .006 | 2.6657 | 11.3090 |
| | 30 | -18.7803* | 1.8741 | .000 | -23.1020 | -14.4587 |
| 30 | control | -12.0480* | 1.8741 | .000 | -16.3697 | -7.7263 |
| | 40 | 25.7677* | 1.8741 | .000 | 21.4460 | 30.0893 |
| | 35 | 18.7803* | 1.8741 | .000 | 14.4587 | 23.1020 |

* The mean difference is significant at the .05 level.

If we are to look carefully at the table above, we will notice that oxygen consumption rate in the control sample after 336 hours is significantly different from the oxygen consumption rate registered by specimens of crucian carp exposed to barium sulphate at concentrations of 40, 35 and 30 mg/l. The highest difference in favour of the control sample with regard to oxygen consumption is 37.815 ml oxygen/kg/hour registered by the control sample at the concentration of 40 mg/l


*Corresponding author, E-mail address: claudiu_alexandru88@yahoo.com

$BaSo_4$, being higher by 196.72% than the difference of oxygen consumption rate between the control sample and the concentration of 40 mg/l $BaSo_4$ after 24 hours. The next difference to appear in favour of the control sample in respect of oxygen consumption is 30.828 ml oxygen/kg/hour registered by the control sample at the concentration of 35 mg/l $BaSo_4$ being 9 times higher than oxygen consumption difference between the control sample and the concentration of 35 mg/l $BaSo_4$ after 24 hours. Finally, the last place is held by the difference between the control sample and the concentration of 30 mg/l $BaSo_4$ with the value of 12.048 ml oxygen/kg/hour, being 12 times lower than oxygen consumption difference between the control sample and the concentration of 30 mg/l $BaSo_4$ after 24 hours.

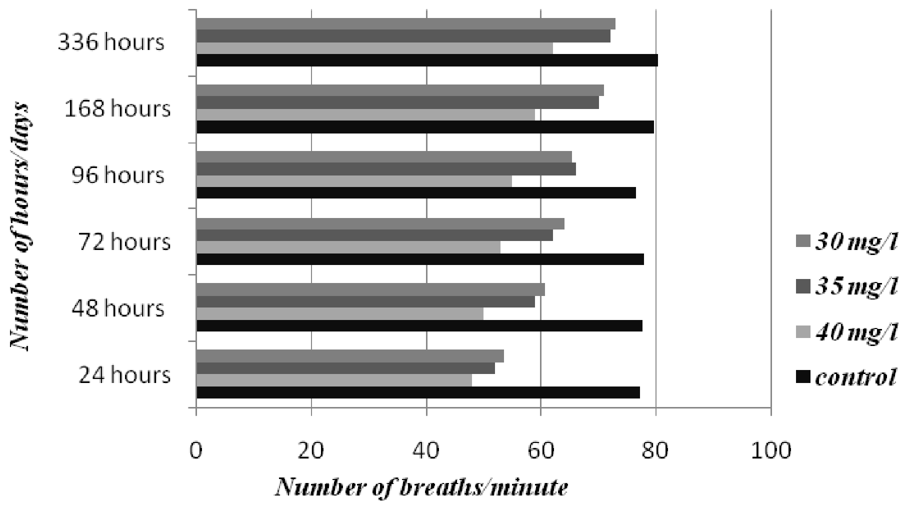


*Figure 2. Effect of barium sulphate over the respiratory rate in Carassius gibelio Bloch, 1782*

Following the chart in fig. 2 we note that within the time-frame 24-336 hours, barium sulphate in all concentrations causes a quite significant decrease of the respiratory rate as compared to that of the control sample, especially during the range 24- 96 hours, where this decrease is quite pronounced, and toward the end of the time- frame, i.e. after 168 and 336 hours, the respiratory rate decreased to a lower extent.

The most extensive decreases in the respiratory rate were registered after 24 hours, first place being held by the concentration of 40 mg/l $BaSO_4$,followed by the concentration of 35 mg/l, and the last place is held by the concentration of 30 mg/l.

The lowest decreases in respiratory rate were registered after 336 hours, where the first place was held by the concentration of 30 mg/l $BaSO_4$, second place by the concentration of 35 mg/l $BaSO_4$, and the concentration of40 mg/l $BaSO_4$ was on the last place.

***Table 5. The average respiratory rate variations to lots of Carassius gibelio Bloch, 1782 exposed to barium sulphate in concentrations of 30, 35 and 40 mg/l water***

| | 24 hours | 48 hours | 72 hours | 96 hours | 168 hours | 336 hours | Mean value |
|---|---|---|---|---|---|---|---|
| control | 77.33 | 77.66 | 78 | 76.66 | 79.66 | 80.33 | 78.27333 |
| 40 mg/l | 48 | 50 | 53 | 55 | 59 | 62 | 54.5 |
| 35 mg/l | 52 | 59 | 62 | 66 | 70 | 72 | 63.5 |
| 30 mg/l | 53.555 | 60.666 | 64 | 65.333 | 71 | 73 | 64.59233 |


*Corresponding author, E-mail address: claudiu_alexandru88@yahoo.com

**Current Trends in Natural Sciences**
Vol. 8, Issue 16, pp. 63-74, 2019
Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521
Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

It follows from the respiratory rate values in all concentrations shown by table 5 that the highest decrease in respiratory rate of the crucian carp specimens (48 breaths/ minute) after 24 hours was seen in the concentration of 40 mg/l $BaSO_4$ registering a 37.93% decrease as compared to the respiratory rate recorded by the control sample (77.33 breaths/ minute), being followed by the concentration of 35 mg/l where respiratory rate value (52 breaths/ minute) was 32.76% lower as compared to the control value above-stated, so that in the end the concentration of 30 mg/l would follow, where respiratory rate (55.35 breaths/ minute) was lower than the control value by 30.76%.
(Mălăcea I., 1969) also reported decreases in the respiratory rate, starting that when oxygen consumption decreased at about 20% of the normal consumption, respiratory rate suddenly decreased until the fish died.
When looking at mean values of the respiratory rate shown in table 4, we note that the highest mean value (64.59 breaths/ minute) registered at the concentration of 30 mg/l $BaSO_4$ is by17.48% lower than the mean value of respiratory rate in the control sample (78.27 breaths/ minute), followed by the mean value of 63.5 breaths/ minute from the concentration of 35 mg/l $BaSO_4$ which is 18.88% lower than the mean value of the control sample mentioned, and in the end there is the mean value of respiratory rate (54/4 breaths/ minute) from the concentration of 40 mg/l $BaSO_4$ by 30.38% lower than the mean control value of oxygen consumption aforementioned.

***Table 6. Multiple comparison between respiratory rate values after 24 hours in the control sample and respiratory rate values of crucian carp specimens exposed to $BaSo_4$ in concentrations of 30 mg/l, 35 mg/l and 40 mg/l***

| | | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| (I) VAR00002 | (J) VAR00002 | | | | Lower Bound | Upper Bound |
| control | 40 | 29.1100* | 1.6367 | .000 | 25.3358 | 32.8842 |
| | 35 | 25.1100* | 1.6367 | .000 | 21.3358 | 28.8842 |
| | 30 | 24.0000* | 1.6367 | .000 | 20.2258 | 27.7742 |
| 40 | control | -29.1100* | 1.6367 | .000 | -32.8842 | -25.3358 |
| | 35 | -4.0000* | 1.6367 | .040 | -7.7742 | -.2258 |
| | 30 | -5.1100* | 1.6367 | .014 | -8.8842 | -1.3358 |
| 35 | control | -25.1100* | 1.6367 | .000 | -28.8842 | -21.3358 |
| | 40 | 4.0000* | 1.6367 | .040 | .2258 | 7.7742 |
| | 30 | -1.1100 | 1.6367 | .517 | -4.8842 | 2.6642 |
| 30 | control | -24.0000* | 1.6367 | .000 | -27.7742 | -20.2258 |
| | 40 | 5.1100* | 1.6367 | .014 | 1.3358 | 8.8842 |
| | 35 | 1.1100 | 1.6367 | .517 | -2.6642 | 4.8842 |

* The mean difference is significant at the .05 level.

If we are to look carefully at table 6 where respiratory rate values from the control sample are compared with respiratory rate values from the experimental samples after 24 hours, we may note that the highest difference (29.110 breaths/ minute) in respect of respiratory rate values is seen between the control sample and the fish sample exposed to $BaSo_4$ in a concentration of 40 mg/l $BaSo_4$. Next, there is the mean difference of 25.110 breaths/ minute occurred between the control sample and the sample of fish exposed to $BaSo_4$ in a concentration of 35 mg/l so that in the end the lowest mean difference of 24 breaths/ minute would follow, recorded between the control sample


*Corresponding author, E-mail address: claudiu_alexandru88@yahoo.com

and the sample of fish exposed to $BaSo_4$ in a concentration of 30 mg/l. All the other three mean differences arisen between the control sample and the samples of fish exposed to concentrations of $BaSo_4$ favoured the control sample.

***Table 7. Multiple comparison between respiratory rate values after 336 hours from the control sample and the respiratory rate values from crucian carp specimens exposed to $BaSo_4$ in concentrations of 30 mg/l, 35 mg/l and 40 mg/l***

| | | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| (I) VAR00002 | (J) VAR00002 | | | | Lower Bound | Upper Bound |
| control | 40 | 18.1100* | 1.6348 | .000 | 14.3400 | 21.8800 |
| | 35 | 10.1100* | 1.6348 | .000 | 6.3400 | 13.8800 |
| | 30 | 7.1100* | 1.6348 | .002 | 3.3400 | 10.8800 |
| 40 | control | -18.1100* | 1.6348 | .000 | -21.8800 | -14.3400 |
| | 35 | -8.0000* | 1.6348 | .001 | -11.7700 | -4.2300 |
| | 30 | -11.0000* | 1.6348 | .000 | -14.7700 | -7.2300 |
| 35 | control | -10.1100* | 1.6348 | .000 | -13.8800 | -6.3400 |
| | 40 | 8.0000* | 1.6348 | .001 | 4.2300 | 11.7700 |
| | 30 | -3.0000 | 1.6348 | .104 | -6.7700 | .7700 |
| 30 | control | -7.1100* | 1.6348 | .002 | -10.8800 | -3.3400 |
| | 40 | 11.0000* | 1.6348 | .000 | 7.2300 | 14.7700 |
| | 35 | 3.0000 | 1.6348 | .104 | -.7700 | 6.7700 |

* The mean difference is significant at the .05 level.

When looking closely at table 7 we will notice that the respiratory rate level registered by the control sample after 336 hours is significantly different from respiratory rate recorded by the crucian carp specimens exposed to barium sulfate at concentrations of 40,35 and 30 mg/l. The highest difference to favour the control sample in respect of respiratory rate is 18.110 breaths/ minute registered between the control sample and the concentration of 40 mg/l $BaSo_4$, being lower by 37.79% than the mean difference of respiratory rate between the control sample and the concentration of 40 mg/l $BaSo_4$ after 24 hours. The following difference seen in favour of the control sample with regard to respiratory rate is 10.110 breaths/ minute registered between the control sample and the concentration of 35 mg/l $BaSo_4$ being by 59.74% lower than the difference of respiratory rate between the control sample and the concentration of 35 mg/l $BaSo_4$ after 24 hours. Finally, last place is held by the difference between the control sample and the concentration of 30 mg/l $BaSo_4$ with a value of 7.110 breaths/ minute, by 70.38% lower than the difference of respiratory rate between the control sample and the concentration of 30 mg/l $BaSo_4$ after 24 hours.

By using ANOVA results (Vutukuru, 2005) showed that in the presence of hexavalent chromium, the normal respiratory activity in Indian major carp, *Labeo rohita* was significantly affected and there is a depression in the metabolic rate at the end of 24, 48, 72 and 96h exposure.

Decreases in the respiratory rate occur since the beginning of the first testing period and they can be attributed to the stress caused by $BaSo_4$.

In the end of the 14 days' test, the specimens of *Carassius gibelio* Bloch, 1782 to have been exposed to concentrations of $BaSo_4$ were slaughtered with a view to determining the red blood cell count and glycaemia values represented by the figures below.


*Corresponding author, E-mail address: claudiu_alexandru88@yahoo.com

Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521

Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

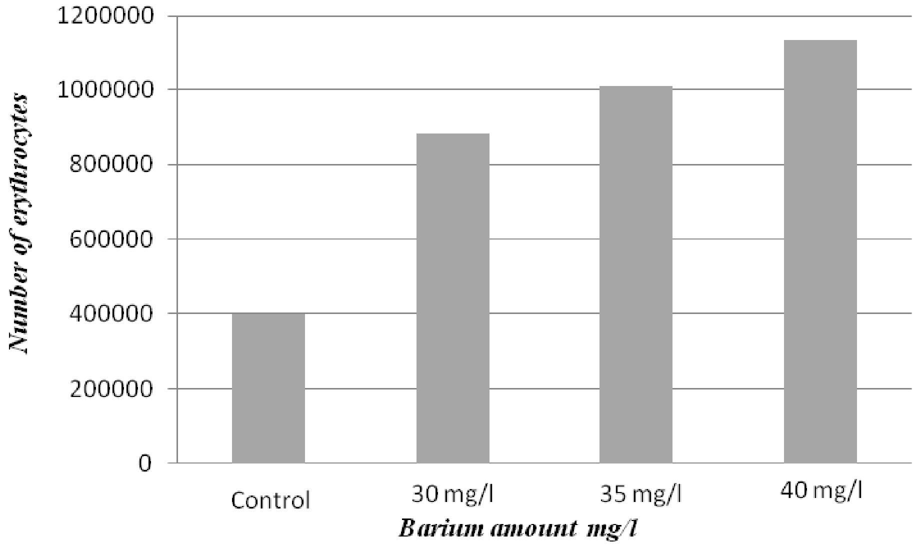


***Figure 3. Influence of $BaSO_4$ over red bloodcell count in Carassius gibelio Bloch, 1782***

Returning to the red blood cell count, we note in fig. 3 that under expose to BaSo4, a significant increase occurs in red blood cell count in all concentrations, so that the lowest increase is emphasized in the concentration of 30 mg/l where red blood cell count registered (881666 erythrocytes/ml blood) is by 120.41% higher than the red blood count recorded by the control sample (400000 erythrocytes/ml blood). Next, there is the concentration of 35 ml/l, where red blood cell count registered (1010000 erythrocytes/ml blood) is by 152% higher as compared with red blood cell count in the control sample shown above, so that in the end there is the concentration of 40 mg/l, where red blood cell count (1132000 erythrocytes/ml blood) is higher by approximately 183% as compared to the control value.

On the other hand, long-term exposure (30 days) to low concentrations of chromium (1.9 and 2.9 mg $L^{-1}$) increased the erythrocyte count, hemoglobin concentration, and hematocrit percentage in the blood of freshwater barbus (*Barbus conchonius* Ham), (Schiffman and Fromm, 1959) and rainbow trout (*Salmo gairdneri*) (Morsy and Protasowicki, 1990).

The reported fluctuations in these blood indices, in addition to differences in species and milieu, may also be attributed to a defense reaction against toxicity through the stimulation of erythropoiesis, and are also indicative of the toxic effects of Cr on both metabolic and hemopoietic activities of *C. carpio* (Parvathi et al., 2011).

The data gathered and displayed in the chart from fig. 4 shows that $BaSO_4$ significantly increases glycaemia in specimens of *Carassius gibelio* Bloch, 1782 in all concentrations experimented.

With regard to the results stated in the chart above depending on the control value of glycaemia (49.33 mg/dl) registered in specimens of crucian carp, we note that glycaemia increased by approximately 29.73% in the concentration of 30 mg/l its value being of 64 mg/dl, followed by an even higher increase by approximately 68.25% at the concentration of 35 mg/l, where glycaemia value is 83 mg/ dl, and in the end the highest increase is seen at the concentration of 40 mg/l, where glycaemia value of 87 mg/dl is higher by 76.36% as compared with glycaemia level from the control sample (49.33 mg/dl).


*Corresponding author, E-mail address: claudiu_alexandru88@yahoo.com

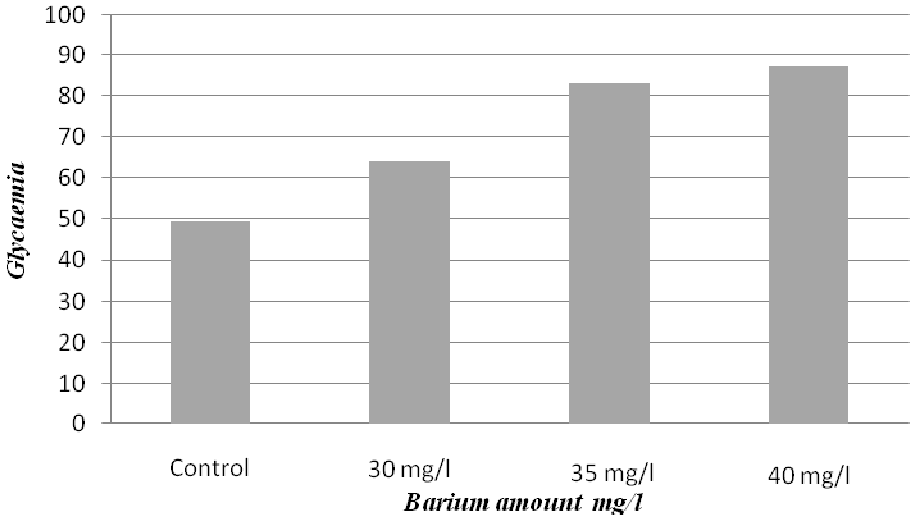


***Figure 4. Influence of $BaSO_4$ over glycaemia in Carassius gibelio Bloch, 1782***

Also arsenic produces hyperglycemic condition in fish which could be manifested by increased blood glucose level and the elevated levels of blood glucose returned to a large existent of the control values after transfer of fish into arsenic free water (Randhir Kumar et al., 2014).
Increased blood glucose content as a result of heavy metals has been attributed to intensive glycogenolysis and the synthesis of glucose from extra hepatic tissue proteins and amino acids (Galvin, 1996) as well as the involvement of Cr in glucose metabolism as an insulin co-factor (Nath and Kumar, 1988).

## 4. CONCLUSSIONS

Significant changes in oxygen consumption, respiratory rate, red blood cell count and glycaemia were recorded under barium exposure in the specimens of *Carassius gibelio* Bloch, 1782, being viewed as responses to the stress caused by particulate matter.
Also all concentrations of $BaSO_4$ reduced oxygen consumption in the specimens of *Carassius gibelio* Bloch, 1782.
Irrespective of its concentration, barium sulphate causes a quite significant decrease of the respiratory rate as compared to that in the control sample.
Exposure to $BaSo_4$ causes a significant increase in the red blood cell count in all concentrations, so the lowest increase was registered in the concentration of 30 mg/l.
Glycaemia increase under exposure to $BaSO_4$ may be associated to a response to metabolic stress.

## 5. REFERENCES

Canli, M., Ay, O., Kalay, M. (1998). Levels of heavy metals (Cd, Pb, Cu, and Ni) in tissue of Cyprinus Carpio, Barbus Capito and Chondrostoma regium from the Seyhan river. *Turkish Journal of Zoology*, *22 (3)*, 149-157.
DeBoeck, G., Desmet, H., Blust, R. (1995). The effect of sub lethal levels of copper on oxygen consumption and ammonia excretion in the common carp *Cyprinus carpio* (L.). *Aquatic Toxicology*, *32*, 127-141.
Dirilgen, N. (2001). Accumulation of heavy metals in freshwater organisms: Assessment of toxic interactions. *Turkish Journal of Chemistry*, *25 (3)*, 173-179.
Dobreva, V., Tsekov, A., Velcheva, I. (2008). Study of the effect of zinc on gill functions of the carassian carp *carassius gibelio* (Boch). *Bulgarian Journal of Agricultural Science*, *14(2)*, 182-185.
Farkas, A., Salanki, J., Specziar, A. (2002). Relation between growth and the heavy metal concentration in organs of bream Abramis brama L. populating lake Balaton. *Archives of Environmental and Contamination and Toxicology*, *43 (2)*, 236-243.
*Fry, F.E.J. (*1967). Thermobiology. Ed. A. H. Rose. Academic Press. London and New York, 375-409.


*Corresponding author, E-mail address: claudiu_alexandru88@yahoo.com

Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521
Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

Galvin, M. (1996). Occurrence of metals in waters: An overview. *Water S A. 22(1)*, 7-18.

Hassan, B.K. (2005). The effect of sub lethal concentration of cadmium on gill and liver of carassian carp *Carassius carassius* (L.). MSc. Thesis, college of Agriculture, Basrah University, 53pp.

James, R. (1990). Individual and combined effects of heavy metals on behavior and respiratory responses of *Oreochromis mossambicus*. *Indian Journal of Fisheries*, *37*, 139-143.

Jezierska, B., Sarnowski, P. (2002). The effect of mercury, copper and cadmium during single and combined exposure on oxygen consumption of *Oncorhynchus mykiss* (WAL.) and *Cuprinus carpio* (L.) larvae. *Archives of Polish Fisheries*, *10(1)*, 15-22.

Malacea, I. (1969). Biologia apelor impurificate. Bazele biologice ale protectiei apelor [Biology of impure waters. Biological bases of water protection], Ed. Academiei RSR, Bucuresti, pp 179.

Morsy, M., Protasowicki, M. (1990). Cadmium bioaccumulation and its effects on some hematological and histological aspects in carp, Cyprinus carpio L., at selected temperature. *Acta Ichthyologica et Piscatoria*. *20*, 105-16.

Muthukumarvel, K., Kumarasamy, P., Amsath, A., Paulraj, M.G. (2007). Toxic effect of cadmium on the electrophoretic protein patterns of gill and muscle of *Oreochromis mssambicus*. *Journal of Chemicals Physics 4(2)*, 284-286.

Nath K, Kumar N. (1988). Hexavalent chromium: Toxicity and its impact on certain aspects of carbohydrate metabolism of the freshwater teleost, Colisa fasciatus. *Science of the Total Environment*. *72*, 175-81.

Parvathi, K, Sivakumar, P, Ramesh, M. (2011). Sublethal effects of chromium on some biochemical profiles of the fresh water teleost Cyprinus carpio. *International Journal of Applied Biology and Pharmaceutical Technology*. *2*:295-300.

Peuranen, S., Vuroinen, P.J., Vuroinen, M., Hollender, A. (1994). The effect of iron, humic acid and low pH on the gills and physiology of brown trout *Salmo trutta*. *Annales Zoologici Fennici*, *31*, 389-396.

Picoş, C.A., Năstăsescu, Gh. (1988). Lucrări practice de fiziologie animală [Practical works of animal physiology], Tipografia Universității din Bucureşti, 107, 122-123, 192-195.

Pora, E.A., Nițu, S., Pora, M., Roşca, I.D. (1952). *Studii şi Cercetări de Biologie*, Cluj 214-224.

Randhir, Kumar, Saumya, Mishra, Amit, Kumar, Singh, Banerjee, T.K. (2014). Changes in the level of blood glucose and tissue glycogen of nutritionally important catfish Clarias batrachus (Linn.) due to Sodium arsenite intoxication. *International Journal of Environment and Natural Sciences*, *1*, 1-7.

Schiffman, R.H., Fromm, P.O. (1959). Chromium induced changes in the blood of rainbow trout, Salmo gairdnerii. *Sewage and Industrial Wastes*, *31(2)*, 205-11.

Shereena, K.M., Logaswamy, S. (2008). Impact of some heavy metals on oxygen consumption by the fish *Tilapia mossambicus*. *Current Biology*, *2(3)*, 300-307.

Starmark, M., Braunbeck, T. (2000). Isolated hepatocytes of Rainbow trout, *Oncorhynchus mykiss* as a tool to discriminate between differently contaminated small river system. *Toxicology In Vitro 14*, 361-377.

Voegborlo, R. B., Methnani, A. M. E., Abedin, M. Z. (1999). Mercury, cadmium and lead content of canned Tuna fish. *Food Chemistry*, *67 (4)*, 341 – 345.

Vutukuru. S. S. (2005). Acute effects of Hexavalent chromium on survival, oxygen consumption, hematological parameters and some biochemical profiles of the Indian Major carp, Labeo rohita. *International Journal of Environmental Research and Public Health*, *2 (3)*, 456- 462.

Yang J., Chen H.C. (2003). Effects of gallium on common carp, *Cyprinus carpio* ;Acute test, serum biochemistry and erythrocyte morphology. *Chemosphere*, *53*, 877-882.

Yousuf, M. H. A., El-Shahawi. (1999). Trace metals in Lethrinus lentjan fish from Arabian Gulf: Metal accumulation in Kidney and Heart Tissues. *Bulletin of Environmental Contamination and Toxicology*, *62 (3)*, 293-300.


*Corresponding author, E-mail address: claudiu_alexandru88@yahoo.com