Journal of Marine Technology and Environment
DOI: 10.53464/JMTE.02.2023.06
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

ASSESSMENT OF THE QUALITY OF THE AQUATIC ENVIRONMENT IN THE AREAS BORDERING THE DEVELOPMENT OF FISHING ACTIVITIES

Simona Ghiță[1], Irina Stanciu[2], Adrian Sabău[1], Sabina Zăgan[2] & Iuliana Șundri[1]

[1]Constanta Maritime University, Faculty of Naval Electro-Mechanics, 104 Mircea cel Batran Street, 900663, Constanta, Romania, e-mail: simona.ghita@cmu-edu.eu, adria.sabau@cmu-edu.eu, iuliana.sundri@cmu-edu.eu
[2]Constanta Maritime University, Faculty of Navigation and Maritime Transport, 104 Mircea cel Batran Street, 900663, Constanta, Romania, e-mail: irina.stanciu@cmu-edu.eu, sabina.zagan@cmu-edu.eu

Abstract: In the present study, the main physical-chemical parameters (temperature, conductivity, turbidity, pH, dissolved oxygen, biochemical oxygen consumption, ammonium, nitrate and phosphate ions) and the representative groups of phytoplankton (green algae, cyanobacteria, diatoms and cryptophytics) are analysed with direct influence on the quality of aquatic life. The average values obtained by analysing the samples collected in July 2023 in the bordering area of fishing activities (marine site –Midia-Navodari area and Lake sites – Tasaul Lake and Siutghiol Lake) are presented and discussed. The modern techniques of in situ analysis of the physical-chemical and biological parameters of the water allowed an evaluation of the quality of the surface waters regarding the trophic potential. The optimal values of the indicators of the eutrophication regime and of the oxygen regime, as well as the presence of the main groups of primary producers, suggest the existence of favourable conditions for the development of fishing and aquaculture activities. The study contributes to the achievement of the general objective of the Dobrogea North FLAG strategy for the development of fishing activities based on the knowledge of environmental aspects, in order to maintain economic and ecological sustainability.
Key words: chlorophyll, eutrophication, fishing, physical-chemical parameters, surface waters

1. INTRODUCTION

Chemical, physical and biological pollution has serious effects on the biosphere, affecting aquatic life, which is why monitoring surface water quality is very important. The Water Framework Directive (Directive 2000/60/EC) establishes a legal framework for the protection and restoration of water quality in Europe, and one of the objectives of the Directive is to achieve a "good ecological status" for surface waters [1].

In this context, eutrophication must be explicitly taken into account. In the area of the Romanian coast and implicitly in the Lakes bordering the maritime area, aquaculture activities were not stimulated.

The implementation of European strategies at the national level, through the development of local groups, such as the Dobrogea Nord Local Group Association (FLAG), allows a consolidation of the Romanian fishing sector, respectively the application of innovative solutions imposed by economic realities. Maintaining the favorable state of the marine aquatic ecosystem in the Midia-Navodari area and the waters of Tasaul and Siutghiol Lakes, as integrated sites in the Dobrogea Nord FLAG territory, brings to the fore the knowledge of the physical-chemical quality of the water and the chlorophyll content as the basis of the trophic level. This evaluation leads to the possibility of knowing the relevant environmental factors in the development of natural fish resources.

The research of the last 20 years has shown an improvement in the quality of the waters and the biological resources of the Romanian Black Sea coast areas after their decline in the 80s of the last century [2], [3], [4], [5].

Regarding the health of aquatic ecosystems, phytoplankton has an important role due to its position as the first link at the base of the food web, as well as in maintaining a good oxygenation of the water.

Some of the most common problems faced by fish species are: insufficient amount of dissolved oxygen, pollution with organic substances, thermal pollution, sound pollution, various obstacles in the way of migration, radioactive pollution, etc. As a result, fish can be used as bio-indicators in the biomonitoring process, but at the same time, by extrapolating the values of the physical, chemical and microbiological parameters, the health status of the fish population present in the water bodies can be predicted.

Numerous studies have highlighted the qualities of phytoplankton as a source of proteins, fatty acids, carbohydrates, vitamins and minerals for aquatic species, it being successfully used in fish food as support for growth and development, as well as for stimulating their immunity [6], [7], [8], [9], [10].

DOI: 10.53464/JMTE.02.2023.06
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

Starting from the premise of a stable ecosystem at the local/regional level, a set of factors can be prescribed to support the efficiency of fishing activities and aquaculture/marine culture farms and even the financial support by the competent bodies of some fish farms within the protected sites of Natura 2000.

Knowing the local environmental conditions by developing an evaluation plan based on the physical, chemical and biological characterization of the marine and Lake environment, can facilitate the mobilization of economic entities towards a common goal.

In this study, we analyzed the main physico-chemical parameters and the concentration of the predominant groups of phytoplankton in three aquatic areas where the development of fishing and aquaculture activities are desired: Siutghiol and Tasaul Lakes, as well as the Midia Navodari coastal marine area.

2. MATERIALS AND METHODS

2.1 Physical-chemical analysed parameters

The main physical-chemical parameters that are the basis for building and understanding the ecological status of water bodies with potential for the development of fishing and aquaculture activities were analysed.

The following physical-chemical parameters:

- temperature (˚C),
- conductivity (mS/cm),
- turbidity (FNU),
- pH and
- dissolved oxygen (mg/l)

were measured in situ with a waterproof meter wits GPS function (HI-9829 multiparameter) at 1meter depth.

For the analysis of the other chemical parameters, the samples were collected at 1meter depth in glass bottles and kept away from light, prior to analysis.

The studied parameters are:

- biochemical oxygen demand (BOD_5),
- ammonium,
- nitrate and
- phosphate ions.

BOD_5 was determined using titrimetric methods. The samples were kept five days at 20^{o}C in a cooler incubator FOC 120I Connect.

Ammonium, nitrate and phosphate ions were measured spectrophotometrically with *SpectroquantPharo 300.*

Before the spectrophotometric determinations, samples were filtered to remove particulate matter.

$N\text{–}NH_4^+$- the method is based on the ammonium ions reaction with hypochlorite, in alkaline solution, in order to form a monochloramine.

This in turn reacts with a substituted phenol to form a blue indophenol derivate that is determined spectrophotometrically in VIS.

$N\text{–}NO_3^-$ - the method is based on the nitrate ions reaction with resorcinol in acidic, in order to form a red-violet indophenol dye that is determined spectrophotometrically.

$P\text{–}PO_4^{-3}$ - the method is based on the orthophosphate ions reaction with molybdic ions, in acid medium, in order to form a phosphor-molybdic complex.

This complex is reduced with ascorbic acid to a blue coloured compound which is measured spectrophotometrically [11].

2.2 Measurement of algal biomass

The biological analysis of the water quality is the basis of some methods of its determination and evaluation.

The biological analysis followed the determination of the chlorophyll content coming from different classes of microalgae, including cyanobacteria.

Methods and instruments for in situ measurements of chlorophyll depend on the absorption efficiency and quantum yield of chlorophyll fluorescence [12], [13].

These technologies are extremely useful in ecological programs developed in marine and lake water bodies.

In this study we used the *FluoroProbe III* instrument developed by bbe-moldaenke Germany(https:// www.bbe-moldaenke.de/en/products/chlorophyll /details/ fluoroprobe.html), which allows the determination of the photosynthetic activity of microalgae using fluorescence measurements in real time at different excitation wavelengths.

FluoroProbe III use 6 LEDs for fluorescence excitation for algae differentiation.

The LEDs emit light at 6 selected wavelengths (370nm, 470nm, 525nm, 570nm, 590nm and 610nm). The division of chlorophyceae (green algae) shows a broad maximum of fluorescence at the 470nm LED, which is caused by chlorophyll-a and -b.

The cyanophyceae (blue-green algae) have their maximum at 610nm due to the photosynthetic antenna pigment phycocyanin.

Cyanophyceae also contain chlorophyll-a if there is low intensity at 470nm. This is due to the masking effect of the phycocyanin.

Furthermore, the high peak at the 525nm region for the bacillariophyceae (diatoms) originates from xanthophyll fucoxanthin and for the dinophyceae from peridin.

The maxima at 470nm are caused by chlorophyll-a and -c.

In our last analysed group, cryptophyceae, a significant maximum can be found at 570nm, which originates from phycoerythrin.

The computer calculates the content of the different divisions of algae in the sample from the sample spectrum and the spectra of the separately measured algae divisions.

The concentration of every algae division is given in µg chlorophyll-a/l.

Journal of Marine Technology and Environment
DOI: 10.53464/JMTE.02.2023.06
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

FluoroProbe III has built-in temperature and pressure sensors. The depth of the FluoroProbe is calculated from the pressure.

The bbe++ software is delivered together with bbe instruments. It provides the following functions:

- operation,
- control and calibration of bbe instruments;
- data analysis and display in tables and diagrams;
- export in different formats.
- The IMPORT function is used to import *.FLP files into the database.
- These files can be results transferred from the FluoroProbe to a USB stick or files generated by the first version of the FluoroProbe software.

The measurements were carried out in the estival season (July 2023) in three sites:

- the Midia Navodari Area (N 44^{0}19'12.3" andE 28^{0}40'30.6") where seines fishing activities are carried out,
- the Tasaul Lake (N 44^{0}19'38.7" and E 28^{0}37'08.4")
- and the Siutghiol Lake (N44^{0}12'57.5" and E 28^{0}37'05.2").

3. RESULTS AND DISCUSSIONS

3.1 Physical-chemical parameters

The determination and evaluation of the physical-chemical parameters of water quality allow the realization of some correlations with the structure of the biota.

Variations in physical-chemical parameters have a large impact on the growth and development of fish populations, and the presence of heavy metals and/or detergents in the water leads to serious imbalances in the metabolic processes of aquatic organisms.

The values for the studied physical-chemical parameters are presented in table 1.

Water temperature influences the survival and reproduction of aquatic organisms. In general, more intense biological activity occurs with increasing water temperature.

Also, the temperature of the water influences the solubility of gases (the solubility of oxygen and carbon dioxide increases with decreasing temperature) and minerals (solubility of most minerals increases with increasing temperature).

The lowest surface temperature was recorded for the Midia Black Sea water (23.11^{o}C), while the temperatures for the water of the Siutghiol Lake (25.61^{o}C) and Tasaul Lake (26.6^{o}C) were approximately 3 degrees Celsius higher.

Table 1. The average values of the physico-chemical investigated parameters

Parameters	**Siutghiol Lake**	**Tasaul Lake**	**Midia**
Temperature (^{o}C)	25.61	26.60	23.11
Conductivity (mS/cm)	2.46	1.93	29.08
Turbidity (FNU)	87.7	71.3	1.0
pH	8.92	8.85	8.3
DO (mg/l)	7.14	7.10	7.37
BOD5 (mg/l)	3.99	6.11	1.59
N-NH_4^+ (mg/l)	0.08	0.28	0.37
N-NO_3^- (mg/l)	0.30	0.26	0.08
P-PO_4^{3-}(mg/l)	0.16	0.80	0.21

The pH is an important indicator of water quality and influences the development of aquatic organisms. Slightly alkaline pH is preferable in waters, as heavy metals are removed by carbonate or bicarbonate precipitates [14].

For optimal growth of most fish species, desirable pH range is 6.5-9.0. Levels below 6.5 leads to a decrease of reproduction [15], while levels higher that 9.0 could produce death of the fish [16].

The time of day a sample is taken influences the pH because of variations in the carbon dioxide concentration in the water. During the day, carbon dioxide in the water is used by algae and plants for photosynthesis and the pH will increase. At night, carbon dioxide is accumulated from the respiration of fish, plants, and other organisms and the pH will decrease.

The analysed samples had close pH values between 8.3 and 8.9. The values for Siutghiol Lake and Tasaul Lake are higher that limit imposed by Order 161/2006 for surface water (8.5) and can suggest possible health disturbances.

Dissolved oxygen represents one of the pollution indicators, along with the biochemical oxygen demand parameter. The biochemical oxygen demand measures the amount of biodegradable organic material present in a water sample, and represents the terms which microorganisms consume the oxygen while degrading these materials.

The dissolved oxygen concentrations for all three analysed sites were very close, around the value of 7mg/L. The analysis of the biochemical oxygen demand shows a very wide variation, both from one site to the

Journal of Marine
Technology and Environment
DOI: 10.53464/JMTE.02.2023.06
ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www.jmte.eu

other and we estimate that they are due to the presence of the humid substances, correlated also with the presence of the yellow substances in the water column.

Ammonia is a dissolved gas present naturally in surface waters and as results from the decomposition of organic matter and the major nitrogenous waste product of fish. Toxicity of ammonia to fish varies with fish species, age and other quality parameters [17].

From the point of view of nitrogen content (N-NH_4^+ and N-NO_3^-) we can say that all the analysed samples are situated in the first class of quality, according to Order 161/2006 (the concentrations of N-NH_4^+ are lower than 0.4 mg/l and the concentrations of N-NO_3^- are lower than 1 mg/l).

Almost all of the inorganic phosphorus in water is in the form of phosphate (PO_4^{3-}). Phosphorus is an essential plant nutrient and the typical range for surface waters is 0.005 to 0.5 mg/l [11]. In accordance with Order 161/2006, the results for phosphate ion concentration place the water from Siutghiol Lake in quality class II (0.16 mg/l) and the water from Tasaul Lake in quality class IV (0.80 mg/l).

3.2 Biological parameters

Fisheries, up to a point, are positively affected by increased primary algal production.

When eutrophication begins to substantially reduce dissolved oxygen concentrations, fisheries can be adversely affected.

Testing the concentration of chlorophyll, the classes of algae and the photosynthetic activity, are useful for the evaluation of eutrophication in the aquatic environment, but also for the evaluation of productivity in most surface waters.

On average, the total phytoplankton concentration showed significant differences in the three investigated water bodies, with a chlorophyll value of 6.5 µg/l in the Midia area on the Black Sea coast, 272.57 µg/l in Siutghiol Lake and 572.69 µg/l in Tasaul Lake. Differences were also recorded in the presence and concentration of the four groups of investigated phytoplankton organisms.

Thus, with a chlorophyll value of 389.82 µg/l, green algae are found in a concentration five times higher in Tasaul Lake than in Siutghiol Lake (76.6 µg/l) and 180 times higher compared to Midia area (2.18 µg/l).

The cyanobacteria group has a chlorophyll concentration of 171.27 µg/l in Siutghiol Lake and 151.59 µg/l in Tasaul Lake.

Diatoms had chlorophyll concentrations of 0.94 µg/l in Tasaul Lake and 4.32 µg/l in Midia.

Chlorophyll recorded in the Cryptophyta group showed a concentration of 24.7 µg/l in Siutghiol and 30.34 µg/l in Tasaul Lake.

Cyanobacteria and cryptophyte groups were not recorded in the Midia area. Also, the group of diatoms was not present in the samples from Siutghiol Lake (Figure 1).

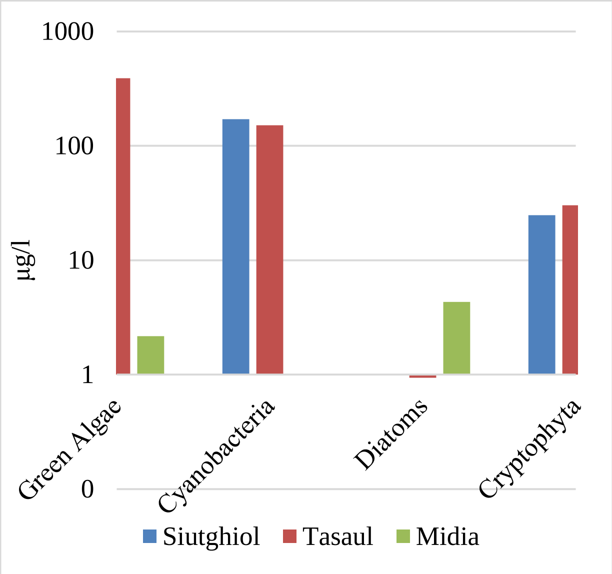

Figure 1 Chlorophyll concentration in the representative groups of phytoplankton

Each of the three aquatic areas presents particularities regarding the rate of different phytoplankton groups.

Thus, in Siutghiol Lake, 62.8% of chlorophyll comes from the group of cyanobacteria, followed by green algae (28.1%).

In contrast, in Tasaul Lake, green algae are predominant (68% of chlorophyll), the chlorophyll of cyanobacteria representing 26.47% of its total.

In the Midia area, diatoms provide 66.49% chlorophyll, followed by green algae (33.51%) (Figure 2).

Phytoplankton is the most sensitive group to the changes of the quality of water parameters.

In order to appreciate the quality and trophic state of a aquatic ecosystem, it is important to determine the concentration of chlorophyll.

The algal bloom evaluated through the lens of the detection of potentially harmful cyanobacteria, aims to assess the quality of the trophic background, as a support for the development of the ichthyofauna in the evaluation area.

In this sense, we note that in Siutghiol and Tasaul Lakes the concentration of cyanobacteria shows a constancy in the water column up to a depth of 1.5 m, so that at more than 2 m in the Siutghiol site triple values (477µg/l) are recorded.

These data are correlated with the presence of the yellow substance that occurs naturally in aquatic environments, originating from detritus or decaying organic material.

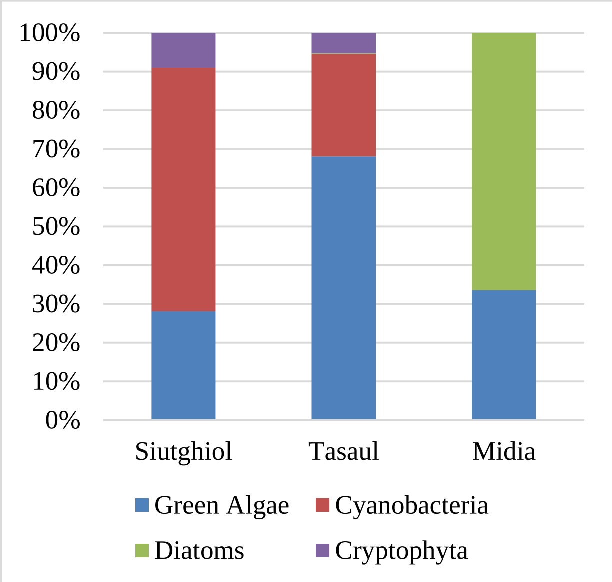

Figure 2 Chlorophyll rate from different phytoplankton groups in the investigated aquatic areas

The concentration of yellow substance (fig. 3) in the Tasaul Lake (19.76 µg/l) is twice as high as in the Siutghiol Lake (8,97 µg/l).

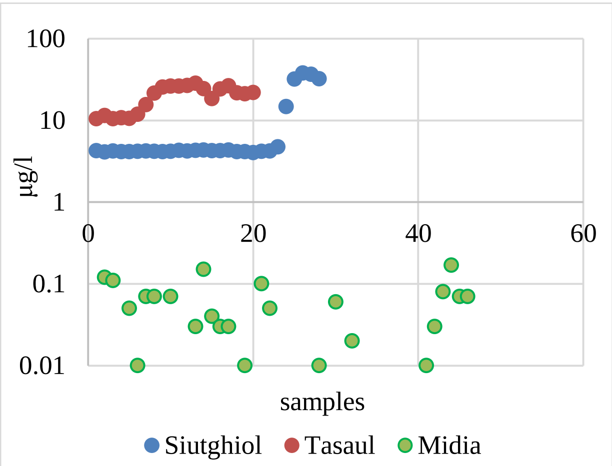

Figure 3 Yellow substance concentration in the investigated aquatic areas

In the marine environment the yellow substance is much lower (0.03 µg/l) compared to the lacustrine environment.

4. CONCLUSIONS

The results obtained in this study suggest the existence of a good trophic base for the development of fishing and aquaculture activities.

The values of quality-monitored parameters depend on the seasonal characteristics therefore it is necessary to continue our research in these aquatic sites.

5. ACKNOWLEDGMENTS

This research was fulfilled with the support of the Romanian Operational Program of Fisheries and Maritime Affairs POPAM 2014 – 2020, within the Area of interest 2.2 “Preservation of natural values and awareness of the risks generated by climate change”.

6. REFERENCES

[1] Anton I.A., Panaitescu M., Panaitescu F-V., Ghiță S., 2018. *Impact of coastal protection systems on marine ecosystems*, EENVIRO 2018 – Sustainable Solutions for Energy and Environment, E3S Web of Conferences 85, 07011 (2019)

[2] Sundri M.I., 2019. *Ecotoxicological assessment of Tabacarie Lake*, Journal of Marine Technology and Environment, vol.2, ISSN: 1844-6116.

[3] Sundri M.I., 2014. *Ecotoxicological assessment in some points of the Romanian Black Sea coastal zone*, Journal of Marine Technology and Environment, Maritime University of Constanta, VOL. I, pg. 79-82, ISSN: 1844-6116.

[4] Zagan S., Enache I., 2019, *Quality parameters of Black Sea water in Constanta City*, Constanta Maritime University Annals, Year X, Vol.12, pg. 261-264.

[5] Stevens T., Mee, L., Friedrich J., Aleynik D., Minicheva G., 2019. *Partial Recovery of Macro-Epibenthic Assemblages on the North-West Shelf of the Black Sea*. Front. Mar. Sci., 31 July 2019, Sec. Marine Conservation and Sustainability, Volume 6.| https://doi.org/10.3389/ fmars.2019 .00474

[6] Nagappan S., Das P., Quadir M.A., Thaher M., Khan S., Mahata C., Al-Jabri H., Vatland A.K., Kumar G., 2021. *Potential of microalgae as asustainable feed ingredient for aquaculture*, Journal of Biotechnology, Volume 341, pg 1-20.

[7] Mahata C., Das P., Khan S.,Thaher M., Quadir M.A., Nagappan Annamalai S., Al-Jabri H., 2022. *The Potential of Marine Microalgae for the Production of Food, Feed, and Fuel (3F)*, MDPI, Fermentation, 8, 316.

[8] Norambuena F., Hermon K.,Skrzypczyk V., Emery J., Sharon Y., Beard A., Turchini G., 2015. *Algae in Fish Feed: Performances and Fatty Acid Metabolism in Juvenile Atlantic Salmon*, PLoS One, 10(4): e0124042.

[9] Ahmad A., W. Hassan S., Banat F., 2022. *An overview of microalgae biomass as a sustainable aquaculture feed ingredient: food security and circular economy*, Bioengineered, Vol. 13, No. 4, pg. 9521–9547.

DOI: 10.53464/JMTE.02.2023.06

ISSN (Print): 1844-6116
ISSN (Online): 2501-8795
https://www. jmte.eu

[10] Cadar E., Negreanu-Pirjol T., Sirbu R., Dragan A.-M.L., Negreanu-Pirjol B.-S., Axente E.R., Ionescu A.-M., 2023. *Biocompounds from Green Algae of Romanian Black Sea Coast as Potential Nutraceuticals*. Processes 2023, 11, 1750. https://doi.org/10.3390/pr11061750

[11] Vasiliu D., Lazar L., Alexandrov L., Cociasu A., Rosioru D., Mateescu R., 2007. *Physical-Chemical Parameters of Tasaul Lake during 2006-2007*, Cercetari Marine, Issue 37, pg. 51-65.

[12] Zeng L., Li D., 2015. *Development of In Situ Sensors for Chlorophyll Concentration Measurement*, Journal of Sensors, Volume 2015, Article ID 903509, 16 pages, https://doi.org/10.1155/2015/903509.

[13] Babin M., 2008. Phytoplankton fluorescence: theory, current literature and in situ measurement, in *Real-Time Coastal Observing Systems for Marine Ecosystem Dynamics and Harmful Algal Blooms: Theory, Instrumentation and Modelling*, M. Babin, C. S. Roesler, and J. J. Cullen, Eds., pp. 237–280, UNESCO, Paris, France.

[14] Ahipathy M.V., Puttaiah E.T., 2006. *Ecological Characteristics of Vrishabhavathy River in Bangalore*, Environmental Geology, Vol. 49, No. 8, pp. 1217-1222. http://dx.doi.org/10.1007/s00254-005-0166-0

[15] Stone N., Shelton J., Haggard B., Thomforde H., 2013. *Interpretation of water analysis reports for fish culture*, Souther Regional Aquaculturem Centre, SRAC Publication no. 4606, https://srac.tamu.edu/.

[16] Dastagir G., Narejo N.T., Jalbani S, 2014. *Physico-chemical parameters and their variation in relation to fish production in Zhob River Balochistan*, Pakistan Journal of Analytical and Environmental Chemistry, vol. 15, no.2, pg. 77-81.

[17] Stavrescu-Bedivan M.M., Scaeteanu G.V., Madjar R.M., Manole M.S., Staicu A.C., Aioanei F.T., Plop E.F., Toba G.L., Nicolae C.G., 2016. *Interactions between fish well-being and water quality: a case study from Morii Lake area, Romania*, Agriculture and Agricultural Science Procedia, 10, pg. 328-339.