DOI: 10.2428/ecea.2013.20(03)038 ECOL CHEM ENG A. 2013;20(3):391-399

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EFFECT OF SUPPLYING FISH PONDS WITH BIOLOGICALLY TREATED WASTEWATER ON THE QUALITY OF POND WATER

WPŁYW ZASILANIA STAWÓW HODOWLANYCH BIOLOGICZNIE OCZYSZCZONYMI ŚCIEKAMI NA JAKOŚĆ WODY W STAWACH

Abstract: Studies on the impact of the effect of supplying fish ponds with biologically treated wastewater on the quality of pond water was carried out in three experimental ponds on the premises of the Wastewater Treatment Plant in Olsztynek in the production season of 2008. The experimental ponds had a surface area in the range of 0.94 ha to 1.04 ha, with a maximum depth of 1.5 m in the summer. Raw wastewater fed to the treatment plant comprised household sewage as well as wastewater from a fruit and vegetable processing plant. Following preliminary treatment, waste was purified biologically in sequencing batch reactors (SBR).

The results of physical and chemical analyses indicate that water in ponds fertilized with biologically treated wastewater was superior in quality in comparison with ponds where conventional breeding methods are applied. In the studied ponds, average ammonia nitrogen concentrations were 4- to 18-fold lower than the lowest average values for ponds supplied with water, fertilized and unfertilized, where fish were fed grain or pelleted feed.

Keywords: fish ponds, wastewater, water quality

Treated wastewater may be supplied to fish ponds as a source of nutrition for fish, namely phytoplankton and zooplankton [1–4], but in most cases, wastewater is fed directly into ponds to intensify the trophic chain and stimulate fish production [5–7]. Various types of pretreated waste, ranging from excrement stored in suspended latrines on ponds [7], raw sewage treated by sedimentation [8], wastewater purified by the activated sludge method [2] to contaminated river water [9], are used to fertilize fish ponds. The referenced studies indicate that wastewater enhances the quality of pond water.

The objective of this study was to evaluate:

– the quality of biologically treated wastewater fed to ponds,

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– the quality of water in ponds supplied with wastewater,

– the option of further purification of biologically pretreated wastewater in fish ponds, based on the analyzed physical and chemical properties of water.

Materials and methods

A field study was carried out in three experimental ponds (Fig. 1) on the premises of the Wastewater Treatment Plant in Olsztynek (N: 53°36′15.29″ E:20°17′20.66″) in the production season of 2008. The experimental ponds had a surface area in the range of 0.94 ha (pond no. 2) to 1.04 ha (pond no. 3), with a maximum depth of 1.5 m in the summer. Raw wastewater fed to the treatment plant comprised household sewage as well as wastewater from a fruit and vegetable processing plant. Following preliminary treatment, waste was purified biologically in *sequencing batch reactors* (SBR).

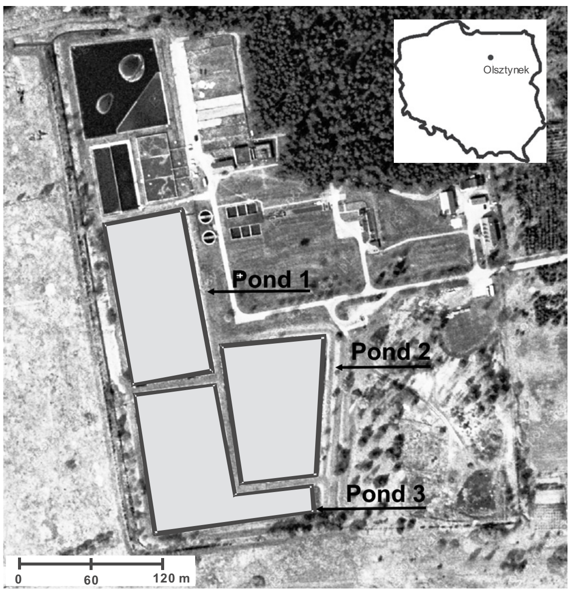

Fig. 1. Experimental ponds in the Wastewater Treatment Plant in Olsztynek

Experimental ponds were filled with water from underground springs at the bottom of ponds 2 and 3, and they were seasonally fertilized with biologically pretreated wastewater. Sewage was fed to pond 1 via a side branch of the main canal evacuating wastewater from the treatment plant. Wastewater was pumped into ponds 2 and 3.

Field measurements and laboratory analyses were performed on a monthly basis between April and October. Samples of raw sewage, biologically treated wastewater and pond water were evaluated. The WTW 350 multi-parameter meter was used to measure: temperature [°C], pH, dissolved oxygen levels [$mgO_2 \cdot dm^{-3}$], oxygen saturation [%] and electrolytic conductivity [$\mu S \cdot cm^{-1}$].

Analytical samples were collected using the following methods:

– raw sewage – with the Ruttner sampler, at the inlet of the grill trap in the waste separation facility,

– biologically treated wastewater – with the Ruttner sampler, in the concrete canal evacuating waste from the plant; wastewater fed to the ponds was collected from the same site;

– pond water was sampled at a depth of 0.5 m.

Laboratory analyses were performed using standard analytical methods (Table 1).

Table 1

Scope and methods of laboratory analyses

No.	Parameter		Methods
1	BOD_5	Biochemical oxygen demand	Respirometric BOD OxiTop Method
2	$N\text{-}NO_3$	Nitrate nitrogen	Colorimetric method using phenolodisulfonic acid
3	$N\text{-}NO_2$	Nitrite nitrogen	Colorimetric method using sulfanilic acid
4	$N\text{-}NH_4$	Ammonia nitrogen	Nessler method
5	TN	Total nitrogen	Kjeldahl method
6	$P\text{-}PO_4$	Phosphates	Colorimetric method using ammonium molibdate with tin(II) chloride
7	P_{tot}	Total phosphorus	Colorimetric method using ammonium molibdate with tin(II) chloride after mineralization

The results were processed statistically using STATISTICA V. 8.0 software (StatSoft, Inc. 2009, www.statsoft.com).

Results and discussion

Biologically treated wastewater was characterized by varied chemical composition, mainly as regards nitrogen and phosphorus compounds. The above could be attributed to differences in waste removal efficiency – nitrogen and phosphorus are generally more effectively removed outside the productive season when the local fruit and vegetable processing plant contributes smaller quantities of wastewater.

From April to October 2008, raw sewage reaching the Wastewater Treatment Plant in Olsztynek was characterized by a temperature of 12.4 ^oC to 24.8 ^oC, pH of 7.2 to 7.9, and low dissolved oxygen levels in the range of 0.03 $mgO_2 \cdot dm^{-3}$ (practically an absence of oxygen) to 0.60 $mgO_2 \cdot dm^{-3}$ (Table 2). Organic load was high with BOD_5 values between 400 to 720 $mgO_2 \cdot dm^{-3}$, and an average of 527.86 $mgO_2 \cdot dm^{-3}$. High levels of organic load resulted from a significant share of wastewater evacuated by the fruit and vegetable plant, which exceeded 50 % of total sewage in some periods. Industrial waste contained much higher levels of carbon compounds than household waste.

In raw sewage, nitrogen was determined mostly in the form of ammonia – 57.5 % (44.02 ± 12.42 $mgN\text{-}NH_4 \cdot dm^{-3}$) and organic nitrogen – 42.3 % (32.38 ± 19.59

Table 2

Physical and chemical composition of raw and treated sewage from the Wastewater Treatment Plant in Olsztynek – production season of 2008

No.	Parameter	Unit	Raw sewage				Treated sewage			
			$\bar{x}$	min	max	SD	$\bar{x}$	min	max	SD
1	Temperature	^oC	20.5	12.9	24.8	4.3	20.1	14.2	25.4	4.0
2	Potential of hydrogen	pH	7.6	7.2	7.9	0.2	7.7	7.3	7.9	0.2
3	Dissolved oxygen	$mgO_2 \cdot dm^{-3}$	0.17	0.03	0.60	0.22	3.54	2.55	4.57	0.82
4	Oxygen saturation	%	1.76	0.30	5.60	1.84	38.97	29.30	49.40	6.86
5	Electrolytic conductivity	$\mu S \cdot cm^{-1}$	1856	1291	2300	334	1885	978	2600	549
6	BZT_5	$mgO_2 \cdot dm^{-3}$	572.86	400.00	720.0	120.10	10.43	5.00	16.00	3.69
7	Ammonia nitrogen	$mgN\text{-}NH_4 \cdot dm^{-3}$	44.02	32.75	65.41	12.42	2.70	0.18	5.60	1.72
8	Non-ionized ammonia	$mgN\text{-}NH_3 \cdot dm^{-3}$	0.5945	0.2015	1.6399	0.4861	0.0664	0.0015	0.1600	0.0564
9	Nitrite nitrogen	$mgN\text{-}NO_2 \cdot dm^{-3}$	0.0043	0.0014	0.0100	0.0028	0.4687	0.2200	0.9240	0.2259
10	Nitrate nitrogen	$mgN\text{-}NO_3 \cdot dm^{-3}$	0.14	0.08	0.17	0.03	4.67	3.04	5.60	0.85
11	Organic nitrogen	$mgN_{org} \cdot dm^{-3}$	32.38	12.27	60.18	19.59	2.62	1.10	4.81	1.45
12	Total nitrogen	$mgTN \cdot dm^{-3}$	76.55	46.35	122.38	26.30	10.47	8.21	12.88	1.80
13	Phosphates	$mgP\text{-}PO_4 \cdot dm^{-3}$	9.67	5.87	14.06	3.05	2.48	1.09	4.95	1.45
14	Total phosphorus	$mgP_{tot} \cdot dm^{-3}$	17.05	10.62	22.79	4.99	5.26	2.36	7.76	2.30
15	Organic phosphorus	$mgP_{org} \cdot dm^{-3}$	7.37	3.42	11.08	2.81	2.78	0.91	6.04	1.80

$\bar{x}$ – mean, SD – standard deviation.

$mgN\text{-}N_{org} \cdot dm^{-3}$) (Table 2). Nitrate nitrogen had a mere 0.18 % share of total nitrogen at 0.14 ± 0.03 $mgN\text{-}NO_3 \cdot dm^{-3}$. The noted nitrogen content is characteristic of Total Kjeldahl Nitrogen values in raw sewage. The studied samples were also characterized by high levels of non-ionized ammonia at 0.5945 ± 0.4861 $mgN\text{-}NH_3 \cdot dm^{-3}$ (Table 2).

As regards the phosphorus content of raw sewage, mineral phosphorus had a 56.7 % share (9.67 ± 3.05 $mgP\text{-}PO_4 \cdot dm^{-3}$), and organic phosphorus – 43.2 % share (7.37 ± 2.81 $mgP_{org} \cdot dm^{-3}$). Raw sewage contained significant quantities of minerals stimulating electrolytic conductivity in the range of 1291 to 2300 $\mu S \cdot cm^{-1}$, with the average of 1856 ± 334 $\mu S \cdot cm^{-1}$ (Table 2).

Biological wastewater treatment in sequencing batch reactors (SBR) supported the removal of organic compounds. BOD_5 values were reduced by 98.2 % to reach 10.43 ± 3.69 $mgO_2 \cdot dm^{-3}$ (Table 2). Dissolved oxygen levels ranged from 2.55 to 4.57 $mgO_2 \cdot dm^{-3}$, oxygen saturation was determined at 38.97 ± 6.86 %, the studied samples had slightly acidic pH, and their temperature varied on a seasonal basis. The use of biologically treated wastewater of the above quality should not lead to a sudden drop in oxygen levels in fish ponds. The supplied effluent's slightly acidic character and temperature similar to that of pond water do not pose a threat to the cultured fish.

Nitrogen and phosphorus compounds were less effectively removed from wastewater than carbon. Total nitrogen concentrations decreased by 86 % to reach 10.47 ± 1.80 $mg \cdot dm^{-3}$. Treated sewage contained mostly nitrate nitrogen at 44 % (4.67 ± 0.85 $mg \cdot dm^{-3}$, Table 3), ammonia nitrogen – 26 %, organic nitrogen – 25 %, as well as nitrite nitrogen – 5 % (0.4687 ± 0.2259 $mg \cdot dm^{-3}$) as the product of nitrification. The concentrations of non-ionized ammonia were determined in the range of 0.0015 to 0.1600 $mg \cdot dm^{-3}$ (Table 2), and they posed a seasonal threat to the health and life of fish.

As a result of denitrification in sequential batch reactors, total nitrogen concentrations in wastewater processed in the Olsztynek plant decreased 3.5- to 4.5-fold in comparison with rural sewage [6, 10] which was also purified by the activated sludge method but with the use of a less effective technology, and more than two-fold in comparison with wastewater from 253 treatment plants in Poland where average concentrations of N were determined at 18.9 $mgN \cdot dm^{-3}$ [10].

Total phosphorus concentrations were reduced by 69 % from 17.05 ± 4.99 $mg \cdot dm^{-3}$ in raw sewage to 5.26 ± 2.30 $mg \cdot dm^{-3}$ in biologically treated wastewater, and mineral phosphorus levels decreased by 47 % (Table 2). The electrolytic conductivity of treated wastewater was high and similar to that of raw sewage.

Phosphate concentrations in treated wastewater were correlated with the levels of nitrate nitrogen and nitrite nitrogen. An increase in phosphate concentrations could result from their release from the sludge into the sewage, under anaerobic conditions, during sewage sedimentation in sequential batch reactors and/or sedimentation in secondary sedimentation tanks [12, 13]. In selected periods of the study, organic phosphorus levels were probably elevated due to the outflow of activated sludge flocs with wastewater leaving the plant.

In the production season of 2008, pond water was characterized by elevated pH levels of up to 9.3, as well as high levels of dissolved oxygen at 10.70 ± 4.42

$mgO_2 \cdot dm^{-3}$ in pond 1, 14.07 ± 4.35 $mgO_2 \cdot dm^{-3}$ in pond 2, and 10.57 ± 4.37 $mgO_2 \cdot dm^{-3}$ in pond 3. Intensified photosynthesis produced relatively high BOD_5 values, which were determined at 6.3 to 8.0 on average, reaching a maximum of 23.0 $mgO_2 \cdot dm^{-3}$ in pond 3 (Table 3).

In all of the analyzed ponds, nitrogen was determined mostly in organic form (Table 3), and its share of total nitrogen varied from 72.0 % in pond 2 to 85.4 % in pond 3. The above resulted mainly from a high rate of photosynthesis and high production of phytoplankton biomass. Pond water was characterized by low levels of non-ionized ammonia which varied insignificantly across the studied reservoirs. Elevated nitrogen concentrations were noted at the beginning of the production season, when wastewater was fed into ponds, as well as at the end of the season, which could be attributed to macrophyte mineralization. Phosphorus was present mostly in organic form (Table 3), and its share of total phosphorus ranged from 78.6 % in pond 1 to 91.7 % in pond 3. Mineral phosphorus was "depleted" on a seasonal basis due to a high rate of photosynthesis and phosphorus uptake by macrophytes.

The results of a statistical analysis indicate that mineral phosphorus and organic phosphorus concentrations did not differ significantly in ponds 1, 2 and 3 ($p \le 0.05$) (Table 3). The pH, levels of organic, nitrite and total nitrogen were significantly higher ($p \le 0.05$) in ponds 1 and 2 than in pond 3. Oxygen saturation was higher in pond 2 in comparison with ponds 1 and 3. The lowest electrolytic conductivity was noted in pond 2. The content of phosphates, non-ionized ammonia, ammonia nitrogen and BOD_5 values in pond 3 were generally significantly lower ($p \le 0.05$) than in the remaining ponds (Table 3). The above could be partially attributed to the inflow of water from underground springs at the bottom of the pond.

The results of physical and chemical analyses indicate that water in ponds fertilized with biologically treated wastewater was superior in quality in comparison with ponds where conventional breeding methods are applied. In the studied ponds, average ammonia nitrogen concentrations were 4- to 18-fold lower than the lowest average values given by Wojda [14], Rahman et al [15], Kolasa-Jaminska [16] and Szumiec [17] for ponds supplied with water, fertilized and unfertilized, where fish were fed grain or pelleted feed.

It can be assumed that the inflow of underground spring water and periodic supply of biologically treated wastewater stimulated the uptake of mineral forms of nitrogen and phosphorus by algae, thus reducing their concentrations in pond water. The above indicates that periodic supply of biologically treated sewage to ponds facilitates the utilization of the introduced minerals, promotes further purification of wastewater and contributes to the renewal of water resources in the pond ecosystem.

The analyzed ponds were also characterized by a more supportive pH than that noted by Szumiec [17] in ponds supplied with water where two-year-old carp were administered pelleted feed. In a study by Szumiec [17], the pH of pond water was determined at 10.95, and high concentrations of ammonia nitrogen were also noted in the range of 0.55 to 4.75, with an average of 1.07 $mg \cdot dm^{-3}$. The above results indicate that the allowable levels of non-ionized ammonia could be exceeded in conventional ponds, posing a toxic risk for fish. In a study by Rahman et al [15], carp (*Cyprinus*

Table 3

Physical and chemical composition of water in ponds on the premises of the Wastewater Treatment Plant in Olsztynek – production season of 2008

No.	Parameter	Unit	Pond 1				Pond 2				Pond 3			
			$\bar{x}$	min	max	SD	$\bar{x}$	min	max	SD	$\bar{x}$	min	max	SD
1	Temperature	^oC	17.2 a	9.4	24.3	4.6	16.9 a	9.5	23.5	4.5	16.6 a	9.6	23.2	4.3
2	Potential of hydrogen	pH	8.4 b	7.6	9.3	0.5	8.6 b	7.7	9.2	0.4	8.1 a	7.6	9.3	0.5
3	Dissolved oxygen	$mgO_2 \cdot dm^{-3}$	10.70 a	2.75	21.80	4.42	14.07 b	6.14	23.30	4.35	10.57 a	5.53	20.80	4.37
4	Oxygen saturation	%	111.9 a	29.2	255.0	47.7	147.6 b	67.9	242.9	48.6	108.4 a	58.2	202.3	40.6
5	Electrolytic conductivity	$\mu S \cdot cm^{-1}$	415 b	354	529	47	398 a	288	474	45	401 ab	255	502	62
6	BZT_5	$mgO_2 \cdot dm^{-3}$	6.7 ab	2.0	17.0	4.0	8.0 b	1.0	21.0	4.7	6.3 a	1.0	23.0	4.5
7	Ammonia nitrogen	$mgN\text{-}NH_4 \cdot dm^{-3}$	0.16 b	0.01	1.00	0.25	0.10 ab	0.01	0.82	0.17	0.06 a	0.01	0.18	0.05
8	Non-ionized ammonia	$mgN\text{-}NH_3 \cdot dm^{-3}$	0.0114 b	0.0007	0.1197	0.0259	0.008 ab	0.0006	0.0538	0.0120	0.004 a	0.0002	0.0513	0.0109
9	Nitrite nitrogen	$mgN\text{-}NO_2 \cdot dm^{-3}$	0.0132 b	0.0016	0.0310	0.0090	0.0160 b	0.0012	0.0286	0.0084	0.006 a	0.0020	0.0142	0.0028
10	Nitrate nitrogen	$mgN\text{-}NO_3 \cdot dm^{-3}$	0.23 b	0.04	0.80	0.22	0.48 c	0.08	1.34	0.42	0.12 a	0.04	0.35	0.09
11	Organic nitrogen	$mgN_{org} \cdot dm^{-3}$	1.46 b	0.36	2.58	0.60	1.52 b	0.34	3.88	0.76	1.11 a	0.34	2.59	0.53
12	Total nitrogen	$mgN_{tot} \cdot dm^{-3}$	1.87 b	0.72	2.71	0.52	2.11 b	0.66	4.17	0.74	1.30 a	0.56	2.73	0.51
13	Phosphates	$mgP\text{-}PO_4 \cdot dm^{-3}$	0.05 c	0.00	0.26	0.07	0.03 b	0.00	0.07	0.02	0.02 a	0.00	0.04	0.01
14	Total phosphorus	$mgP_{tot} \cdot dm^{-3}$	0.28 a	0.08	0.60	0.17	0.27 a	0.06	0.72	0.16	0.24 a	0.04	0.55	0.14
15	Organic phosphorus	$mgP_{org} \cdot dm^{-3}$	0.22 a	0.04	0.58	0.15	0.24 a	0.03	0.70	0.16	0.22 a	0.04	0.53	0.14

a, b, c, - data groups differ significantly in Duncan test at $p \leq 0.05$

carpio L.) breeding ponds, which were supplied with water, fertilized, and where fish were administered pelleted feed, had acidic pH of 6.5, whereas the pH of ponds investigated in this study did not decrease below pH 7.6.

Although research results do not suggest a deterioration in water quality at the pH of 7.6, and some authors [18, 19] find the above pH value to be within the limits of safety, Moriarty [20] argues that a drop in water pH could be indicative of undesirable processes in the pond, such as organic matter decomposition, elevated carbon dioxide levels and lower oxygen concentrations.

In the analyzed ponds, oxygen saturation was higher than the average of 68 and 90 % saturation levels noted in conventional fish ponds [17]. In the cited study, minimal oxygen saturation was 14 %. According to reference data [18, 19, 21], such low oxygen saturation levels not only inhibit fish growth, but they can also lead to fish mortality, subject to pH and the concentrations of non-ionized ammonia [22]. In the studied ponds, average oxygen concentrations were more than two-fold higher than those noted in ponds supplied with organic and mineral fertilizers [15], as well as in unfertilized ponds where carp were fed ground barley [14].

Conclusions

1. Biologically treated household sewage and wastewater from fruit and vegetable processing plants can be used to fertilize fish ponds.

2. Biologically treated wastewater was characterized by low BOD_5 values which suggest a low organic matter content. Relatively high nitrogen and phosphorus concentrations indicate that biologically purified sewage is a potent fertilizer.

3. The presence of mineral compounds in biologically treated wastewater can enhance the mineral composition of water in fish ponds.

4. Water in ponds supplied with biologically treated sewage was characterized by high oxygen saturation and low concentrations of ammonia nitrogen and non-ionized ammonia which did not pose a health and life hazard for fish.

References

[1] Holmer M. Environmental issues of fish farming in offshore waters: perspectives, concerns and research needs. Aquacult Environ Interact. 2010;1:57-70.

[2] Tucholski S. Chów ryb w stawach zasilanych biologicznie oczyszczonymi ściekami. Olsztyn: Wyd IRŚ; 1994:1-20.

[3] Tucholski S, Niewolak S. Stawy rybne jako III stopień oczyszczania w małej biologicznej oczyszczalni ścieków. Zesz Nauk AR Wrocław. 1994;246:179-189.

[4] Golder D, Rana S, Sarkar D, Jana BB. Human urine is an excellent liquid waste for the culture of fish food organizm, Moina micrura. Ecolog Engin. 2007;30:326-332.

[5] Hargreaves JA. Nitrogen biogeochemistry of aquaculture ponds. Aquaculture. 1998;166:181-212.

[6] Tucholski S. Wartość nawozowa ścieków wiejskich odpływających z oczyszczalni mechaniczno--biologicznej. Zesz Probl Post Nauk Roln. 2001;475:87-94.

[7] Edwards P. Development status of, and prospects for, wastewater-fed Aquaculture in urban environments. In: Urban Aquaculture. Costa-Pierce B, Desbonnet A, Edwards P, Baker D, editors. Wallingford Oxfordshire: CABI Publishing; 2005: 45-59.

[8] Kufel L. Are fishponds really a trap for nutrients? – A critical comment on some papers presenting such a view. J Water Land Dev. 2012;17:39-44.
[9] Liang Y, Cheung RYH, Everitt S, Wong MH. Reclamation of wastewater for polyculture of freshwater fish: fish culture in ponds. Wat Res. 1999;33(9):2099-2109.
[10] Bernacka J, Pawłowska L. Zmiany w gospodarce osadowej miejskich oczyszczalni ścieków w latach 1994-2004. Warszawa: Wyd IOŚ; 2006:1-47.
[11] Sobik-Szołtysek J, Jabłońska B. Possibilities of joint management of sewage sludge and dolomite post-flotation waste. Ecol Chem Eng S. 2010;17(2):149-159.
[12] Henze M, Harremoës P, Jansen JC, Arvin E. Oczyszczanie ścieków. Procesy biologiczne i chemiczne. Żygadło M, Bartkiewicz B, tłumaczenie. Kielce: Wyd Politech Świętokrzyskiej; 2002:1-360.
[13] Raczyńska M, Machula S, Choiński A, Sobkowiak L. Influence of the fish pond aquaculture effluent discharge on abiotic environmental factors of selected rivers in Northwest Poland. Acta Ecologica Sinica. 2012;32:160-164.
[14] Wojda R. Karp. Chów i hodowla. Poradnik hodowcy. Olsztyn: Wyd IRŚ; 2009:1-318.
[15] Rahman MM, Verdegem M, Nagelkerke L, Wahab MA, Milstein A, Verreth J. Effects of common carp Cyprinus carpio (L.) and feed addition in rohu Labeo rohita (Hamilton) ponds on nutrient partitioning among fish, plankton and benthos. Aquaculture Res. 2008;39:85-95.
[16] Kolasa-Jamińska B. Investigations on intensification of carp fingerling production. 5: Physical and chemical properties of water. Acta Hydrobiol. 1987;29(3):325-337.
[17] Szumiec J. Effects of diversified pond carp culture. 1: Impact of different feeding and stock density on fish production. Acta Hydrobiol. 1995;37(1):131-138.
[18] Bieniarz K, Kownacki A, Epler P. Ekologia stawów rybnych. In: Biologia stawów rybnych. Olsztyn: Wyd IRŚ; 2003, cz I: 5-100.
[19] Degefu F, Mengistu S, Schagerl M. Influence of fish cage farming on water quality and plankton in fish ponds: A case study in the Rift Valley and North Shoa reservoirs, Ethiopia. Aquaculture. 2011;316,129-135.
[20] Moriarty DJW. The role of microorganisms in aquaculture ponds. Aquaculture. 1997;151:333-349.
[21] Sidoruk M, Koc J, Szarek J, Skibniewska K, Guziur J, Zakrzewski J. Effect of trout production in concrete ponds with a cascading flow of water on physical and chemical property of water. J Ecol Eng. 2013;34:206-2013.
[22] Bobrecka-Jamro D, Kwiatkowska A, Jarecki W. Skład i właściwości ścieków oczyszczonych. Zesz Probl Post Nauk Roln. 2005;506:47-54.

WPŁYW ZASILANIA STAWÓW HODOWLANYCH BIOLOGICZNIE OCZYSZCZONYMI ŚCIEKAMI NA JAKOŚĆ WODY W STAWACH

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Abstrakt: Badania dotyczące wpływu zasilania stawów hodowlanych biologicznie oczyszczonymi ściekami na jakość wody w stawach przeprowadzono w sezonie hodowlanym 2008 w trzech stawach doświadczalnych o powierzchni od 0,94 ha do 1,04 i maksymalnej głębokości w okresie letnim 1,5 m, położonych na terenie Oczyszczalni Ścieków w Olsztynku. Ścieki surowe dopływające do oczyszczalni stanowiły mieszaninę ścieków bytowo-gospodarczych i z przetwórstwa owoców i warzyw. Po oczyszczaniu wstępnym oczyszczano je biologicznie w sekwencyjnych reaktorach (SBR).

Wyniki badań składu fizykochemicznego wody w stawach doświadczalnych użyźnianych biologicznie oczyszczonymi ściekami wskazują, iż charakteryzowały się one lepszą jakością aniżeli wody w stawach o konwencjonalnych warunkach chowu ryb. Średnie stężenie azotu amonowego w wodzie stawów doświadczalnych było od 4 do 18 razy niższe w porównaniu do najniższych średnich wartości w stawach zasilanych wodą, nawożonych lub nienawożonych, w których ryby żywiono paszą zbożową lub mieszanką granulowaną.

Słowa kluczowe: stawy hodowlane, ścieki, jakość wody