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# Environmental load of wels (*Silurus glanis*) fed by feeds of different protein levels

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**Abstract**. The most dangerous effect of the environment on traditional and intensive fish farming is the released nutriment loaded effluent water. Intensity is increased and the nutriment intake by artificial feeds cannot be utilized all by fish. Parts of these remain in the system in particulate or dissolved form and begin to accumulate, may cause insufficient water quality. During our experiment we examined the environmental effects of three different feeds of different protein levels. The declared crude protein contents of feeds were 33%, 40% and 49%. At the beginning of our research, catfish were fed by feeds of 1% of bodyweight. We measured the inorganic dissolved nitrogen forms of water before adding nourishment and after in the 6th, 12th, 24th, 36th, 48th, 60th and 72nd hours. Before sampling we checked the main physical and chemical parameters of water which are essential to analysis. With regard to the results, the concentrations of ammonium nitrogen were permanently increased in control and also in the other treatments during the 72h examined period.
**Key Words**: European catfish (*Silurus glanis)*, artificial feed, environmental load, dissolved inorganic nitrogen.

**Kivonat**. A hagyományos és intenzív haltermelő rendszerek természetes környezetet leginkább veszélyeztető hatása a szennyező anyagok elfolyó vízzel történő kibocsátása. A haltermelés intenzitásának növekedésével, a takarmánnyal rendszerbe juttatott tápanyagok egy része hasznosul, míg a további hányad kötött, illetve oldott formában a rendszerben marad, felhalmozódik és a vízminőség romlásához vezet. Kísérletünkben három eltérő fehérje tartalmú táp *in vitro* környezetre gyakorolt hatását vizsgáltuk. A tápok deklarált nyersfehérje tartalma 33%, 40%, illetve 49% volt. A kezelések kezdetén az állomány - testtömegnek megfelelő - 1%-nyi takarmányt kapott. A szervetlen oldott nitrogénformák (DIN – dissolved inorganic nitrogen) $NH_4^+$-N, $NO_2^-$-N, $NO_3^-$-N koncentrációját mértük a nevelő kádakban az etetést megelőzően, majd az etetést követő 6 - 12 - 24 - 36 - 48 - 60 - 72. órákban. Az egyes mintavételek alkalmával rögzítettük a fontosabb fizikai és kémiai paramétereket, melyek nélkülözhetetlenek az elemzéshez. Ammónium-nitrogén koncentrációk esetében, mind a kontroll, mind a kezelt csoportokban folyamatos növekedést tapasztaltunk a 72 órás vizsgálati időszakban.
**Kulcs szavak:** harcsa (*Silurus glanis*), táp, környezeti terhelés, DIN – oldott szervetlen nitrogén

**Introduction**. Limited volumes of freshwater sources widely contribute to environmentally friendly farming technologies. Sustainable development means economical use of resources, protection and improvement of the environment. The most dangerous effect of farming technologies is effluents loaded with organic and inorganic matters (Kestemont 1995). The main problem for natural waters is the growing amount of carbon, nitrogen and phosphorus concentrations. These components all come from remaining nutriments (Mires 1995; Dodds & Welch 2000; Kronvang et al 2005). Intaken nutritive matters are utilized during the production only at 20-30% efficiency. This is caused by biological and technological reasons (Avnimelech et al 1995; Hargreaves 1998; Brune et al 2003; Avnimelech 2006).

Non-utilisation of nutrients by aquaculture causes accumulation, thus the quality of water depletes. Flow-through systems have no water attendant units, so effluents leaving the systems load natural waters, encouraging eutrophication. Water attendants of recirculating aquaculture systems (RAS) discharge non-used nutriments supported by nitrifying bacteria in regular methods and release nitrogen gas and carbon-dioxide into the atmosphere. Finally the utilization of valuable nutrients is only about 30% (Gál et al 2003; Kerepeczki et al 2003; Gál et al 2006).

According to Gál (2006) intensive (mostly flow-through) systems load receiver waters with 100t of nitrogen, 700t of organic matter and 30t of phosphorus annually in Hungary and he suggests using combined systems where traditional farming technologies can decrease the effect of effluents on the natural environment (Schneider et al 2005; Gál et al 2007).

Changing habits of consumers increase the interest for valuable predatory fish species produced by artificial feeds in intensive industrial method (Gál et al 2003). The high content of crude protein of feeds intensely loads receiver waters (Torres-Beristain et al 2006). Nitrogen origins from artificial feeds and enters the water by the excretion of gills of fish in form of ammonia. In water the ammonia is present in $NH_4^+$ and $NH_3$ forms. These forms can be transformed by nitrifying bacteria into nitrite and nitrate (Hagopian & Riley 1998; Gross et al 2000) or taken up directly by algae.

Researchers in the USA examined channel catfish (*Ictalurus bipunctatus*) in ponds. They analyzed the quality of effluents and the quantity of nitrogen forms. The results show that total nitrogen (TN) content of water was highly associated with the biomass of phytoplankton (higher in summer). However the amount of inorganic nitrogen forms is significantly higher in winter because of the limitation of assimilation (Tucker & Hargreaves 2003).

**Material and Method**. During our experiment we measured the environmental impact of feeds of different protein levels in case of wels (*Silurus glanis*), in consideration of the amount of dissolved inorganic nitrogen forms enriched in water. This examination was carried out in the fish laboratory of the University of Pannonia in Hungary. Fish were held in a RAS (adaptation) before the experiment, which consisted of 12 pieces of 180L tanks. Fish were starved for three days before the examination. Fish tanks were supplied with air diffuser one by one and the water circulation was continuous.

At the start of our research the circulation was stopped. Sixty catfish (364.76±97.03g /mean±SD/) were used (five per/tank), which were weaned onto artificial diets. Besides control groups, we applied three treatments in three replicates: 33% crude protein content artificial feed, 40% and 49% (these are declared values by producers). Control groups didn't receive feed, however experimental groups 1% of bodyweight feeding was applied immediately after first water samplings. The three different feeds consisted of the following: Coppens Carpco Standard (crude protein content 33%), Skretting Classic K2P (40%), Coppens Steco Supreme (49%). Results of analysed feeds are shown in Table 1.

Table 1

Analyses of applied artificial feeds

| declared crude protein content | measured dry matter (%) | measured crude protein (%) | measured crude ash (%) | measured crude fat (%) | measured crude fibre (%) | measured N (%) | measured ME fish (MJ/kg d.m.) | measured NFE (%) |
|---|---|---|---|---|---|---|---|---|
| **33%** | 95,60 | **34,36** | 6,41 | 5,35 | 3,98 | **5,49** | 13,27 | 45,51 |
| **40%** | 89,50 | **37,87** | 5,80 | 10,46 | 3,14 | **6,06** | 14,56 | 32,23 |
| **49%** | 91,90 | **45,85** | 9,50 | 9,13 | 0,99 | **7,33** | 14,21 | 26,43 |

Notation: N - content (%), ME – metabolic energy [MJ x $kg^{-1}$ dry matter], NFE – N free extract (%).

During samplings we measured water temperature (23.1±0.3$^o$C), dissolved $O_2$, $O_2$%, pH and collected 50-50mL water samples per parameter and set them (sulphuric acid: ammonium-nitrogen, refrigeration to 1-4$^o$C at nitrite/nitrate-nitrogen). MSZ – EN - ISO 11732:2005 and MSZ - EN - ISO 13395:1999 standards were adopted by us.

Data was processed by Microsoft Office Excel 2007, and SPSS 9.0 for Windows.

**Results and Discussion**. We found remarkable differences between the declared and measured crude protein contents. During the assessment we considered measured values (we used declared contents on figures for easier understanding) (Table 1). Measured contents of parameters are shown in Figure 1: ammonium-nitrogen, Figure 2: nitrite-nitrogen and Figure 3: nitrate-nitrogen. In order to compare the results we used relative nitrogen contents (ion concentration x kg fish$^{-1}$).

In cases of $NH_4^+$-N (Figure 1) all three treatments and control groups have a growing tendency in concentrations. Medium crude protein content feed significantly differed from the control group ($p<0.05$) following the three day experiment. However 33% and 40% feeds didn't effect remarkable excursions. With regard to the control group we notice that after a six days starvation period fish excrete small-scales of ammonia.

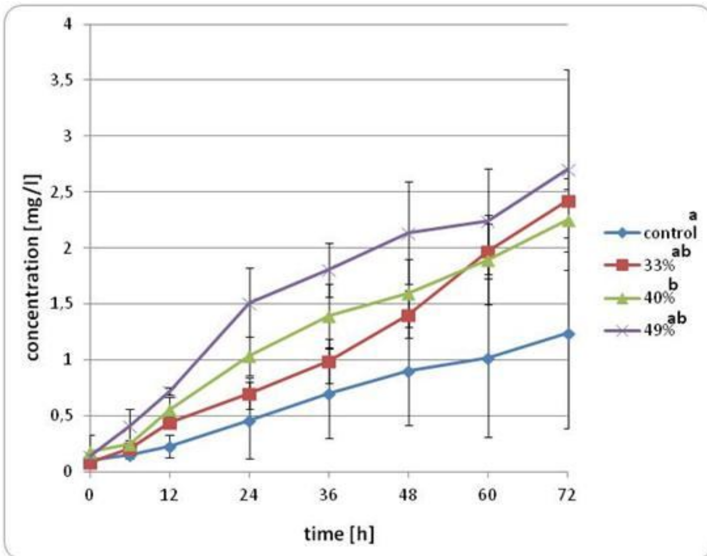


Figure 1. Amount of ammonium-nitrogen
(different letters are meaning significant ($p<0.05$) differences at 72h).

In cases of $NO_2^-$-N – quantity depends on the rate of nitrification (Hagopian & Riley 1998) – obvious differences are shown after the three day treatments. Treatments all differ significantly from control group, and each other ($p<0.05$) (Figure 2).

Regarding the results of $NO_3^-$-N – which is the terminal product of nitrification (Hagopian & Riley 1998) – after 72h feeds of 33% and 40% crude protein content differed significantly ($p<0.05$) from the control group, however highest protein content didn't result in remarkable excursions (Figure 3).

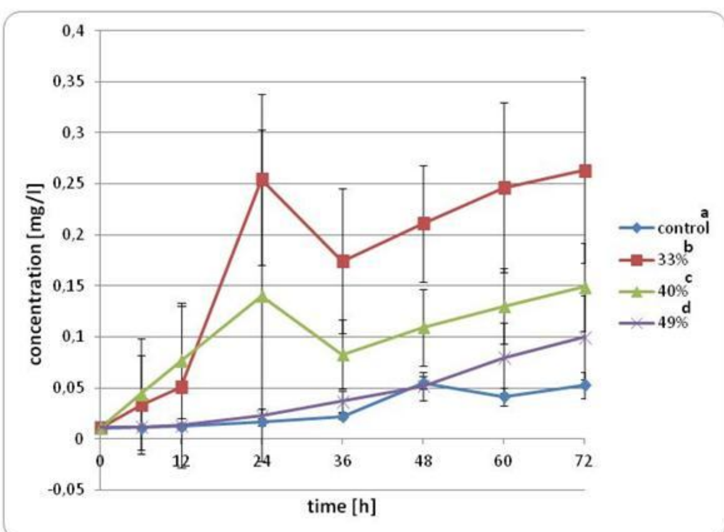


Figure 2. Amount of nitrite-nitrogen
(different letters are meaning significant ($p<0.05$) differences at 72h).

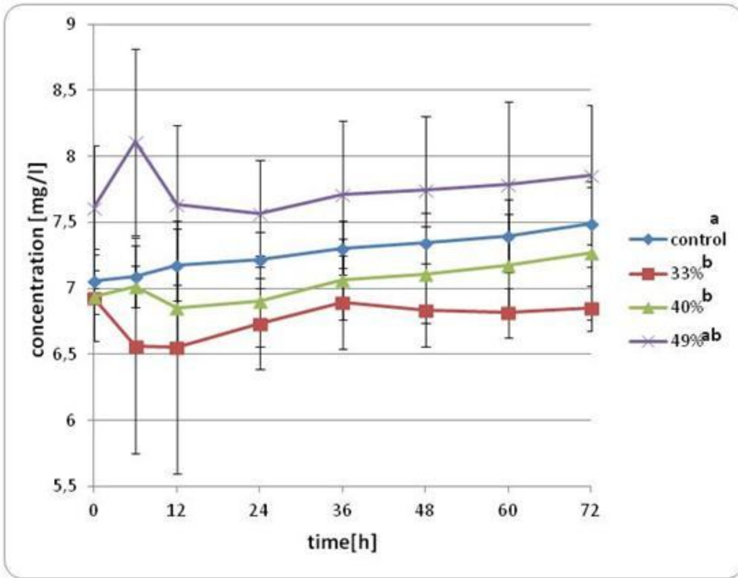


Figure 3. Amount of nitrate-nitrogen
(different letters are meaning significant ($p<0.05$) differences at 72h).

Initial time pH values were about 8.6 (Figure 4); however at the end of the experiment these decreased more than 0.5 unit. This may be caused by nitrification and carbon-dioxide generated by respiration. Uncommon values at the beginning are local characters and did not reach critical levels (Brune et al 2003).

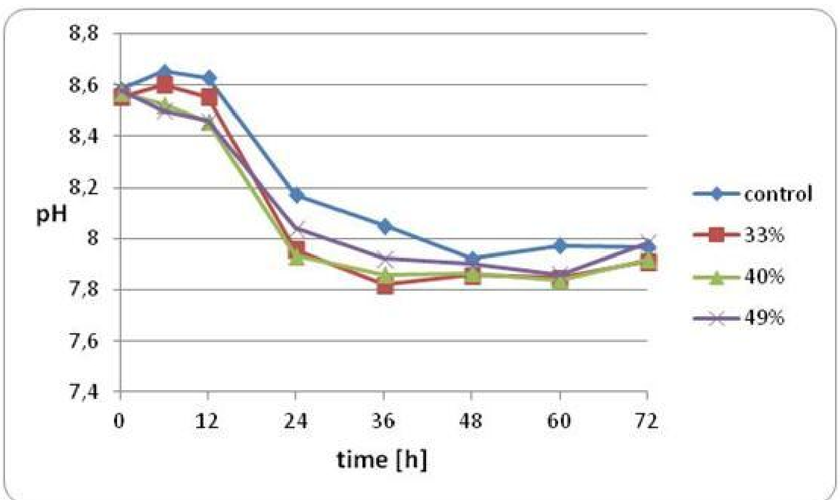


Figure 4. pH fluctuation.

Amount of intaken relative N (N x kg fish$^{-1}$) and dissolved inorganic relative nitrogen forms (dissolved ion x kg fish$^{-1}$) are presented together in Figure 5. In the case of the control group there is no N from feed, but at treatment points protein and N contents also increased. As much as 81.9% of N dissolved to inorganic forms in 33% feed. The N content of 40% feed was 75% in inorganic N matters, and 71% of 49% feed was in dissolved inorganic nitrogen.

**Conclusions**. Feeds of different protein levels loaded the environment differently after a three day period. In case of ammonium-nitrogen the medium feed (40%) differed statistically, however all groups (33%-40%-49%) demonstrated differences of nitrite-nitrogen. Results of 33% and 40% groups were significantly different in the amount of nitrate-nitrogen ($p<0.05$).

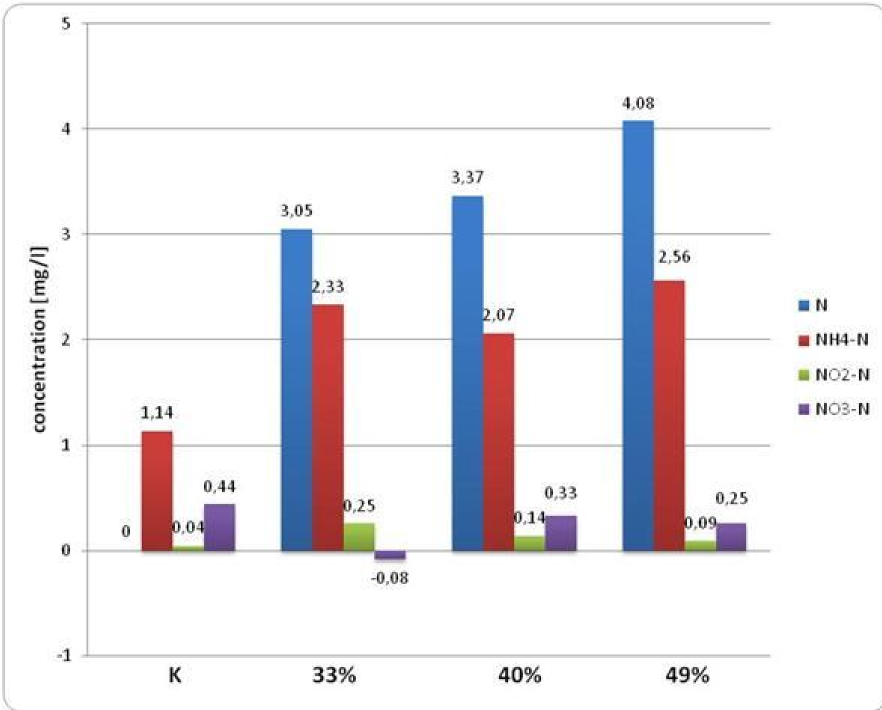


Figure 5. Results together; dependence of DIN (dissolved inorganic nitrogen) and N contents on feeds.

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