AACL BIOFLUX

Aquaculture, Aquarium, Conservation & Legislation
International Journal of the Bioflux Society

Intensive rearing of wels (*Silurus glanis*) fed with plant protein based feed

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Abstract. In order to replace expensive fish meal, plant based feeds were compared to traditional wels (*Silurus glanis*) feed in a 60 days experiment. Three types of feed were applied squealer feed (S), squaeler feed combined with forage fish (S+F) and standard wels feed (W). The feed conversion ratio was 0.88±0.21 at the W group, 1.74±0.21 at the S and 1.48±0.23 in case of S+F group. Specific growth rate was higher at wels feed (2.34%), than in the case of the squealer feed (1.77%) or even in the case of forage fish addition (1.95%). The slaughter loss was the least at the fish fed with forage fish in addition (34.6±2.0%). The size of the liver (2.8±0.32%) and the fat content of the viscera (4.1±1.0%) was significantly higher at W group than those of the other treatments.
Key Words: wels, intensive, plant protein, growth.

Kivonat. Az egyre drágább halliszt kiváltására, a harcsa növényi tápon való nevelésének lehetőségét vizsgáltuk. A 60 napos kísérlet során háromféle takarmányozást hasonlítottunk össze: harcsatáp, malactáp, illetve hal-kiegészítés malactáp etetése mellett. A takarmányértékesítés a harcsatápos kezelés esetében 0,88±0,21 volt, míg a malactápos csoport esetében 1,74±0,21, a hal-kiegészítéses csoportnál 1,48±0,23. A növekedés üteme a harcsatápos csoport esetében gyorsabb (SGR átlag: 2,34%), mint a malactápos (1,77%), ill. a hal-kiegészítéses csoport esetében (1,95%). A törzs vágási veszteségei a hal-kiegészítéses csoport esetén a legkisebbek (34,6±2,0%). A máj mérete (2,8±0,32%) és a hasűri zsírfelhalmozás mértéke (4,1±1,0%) a harcsatápos csoport esetében szignifikánsan nagyobb, mint a másik két kezelés esetén.
Key Words: harcsa, intenzív, növényi fehérje, növekedés.

Introduction. Nowadays fish in intensive rearing facilities are usually fed with feeds containing fish meal as primary protein source. The catches of those species providing the raw material of the fish meal have been stagnating or decreasing globally since the beginning of the 90's (Astles et al 2009; Caddy & Garibaldi 2000; Johnsen 2005). In the recent years total marine capture is approximately 81-84 million tons per year (FAO Fisheries and Aquaculture Department, 2009). Because of the overexploitation of seas the sustainability of this practice became uncertain. Production cost of fish meal increases extremely fast. Since 2004 the price of fish meal has doubled (FAO Fisheries and Aquaculture Department, 2009). The price of the feeds takes most of the charges (50-90%) of an intensive/super-intensive fish culture (Müller 1990). It is of primery interest to decrease the feed prices by using cheaper feed components.

It is also necessary to reduce the amount of the fish meal in the commercial fish feeds or substitute it with alternative protein sources (e. g. plant protein, fermentation products) (Ai & Xie 2006). This ambition isn't unique in the world. In the USA farmers breed channel catfish (*Ictalurus punctatus*) on industrial scale by feeding plant based protein. Recent years the production level exceeded the 270 000 tons pro year (Stickney 2010).

The market requires the constant, reliable production. This can be provided mostly in intensive rearing systems. There is a native European catfish species which is appropiate for this purpose, the wels (*Silurus glanis*). The flesh of wels is boneless, delicious, white coloured and tasty. It is easy to train wels on artificial, formulated feed and it has good food utilization ability. Wels is resistant against harm during handling and it's oxygen demand is similarly low to carp. Wels production in Hungary is relatively low, it takes only 1-2 % of the total fish pond production. In 2008 the total wels production took only 239.6 tons, while the capture on natural waters took 168.8 tons (Pintér 2009). Hungarian and foreign papers proofed that wels is a suitable species for intensive rearing in ponds either cages. In this survey the possibilities of rearing wels on plant based feed were examined.

Material and Method. This examination was carried out in the fish laboratory of the University of Pannonia in Hungary. Fish were held in an approx. 4000 L recirculation system, which was consisted of 9 pieces of 350 L fish tanks (60cm*50cm*130cm)and 3 pieces of 300 L settling, filtering and puffer tanks. Perlon wool was used as filter material, ion exchange marbles were used to eliminate harmful NH_3/NH_4^+ nitrogen forms. In addition a UV-lamp was built into the system as biocide. Fish tanks were supplied with air diffuser one by one. *Faeces* and remains of feed were sucked out with a rubber pipe every morning. The quantity of daily removed water was approx. 2.5%. The loss was complement every time with fresh water directly from the tap. The room was dimmed and the temperature was held between 20 °C and 25 °C (mean±SD: 22.3±1.3°C). Water temperature was measured daily (Figure 1).

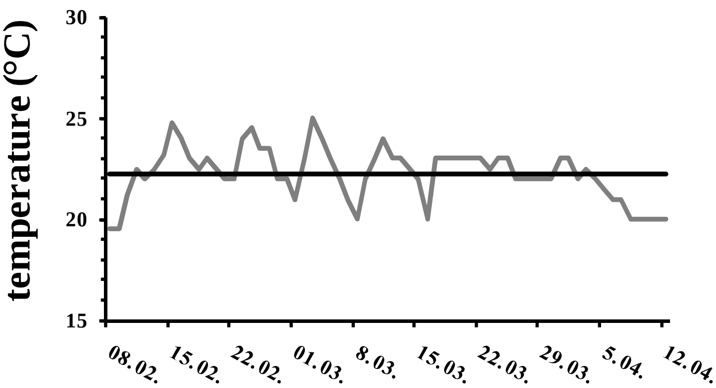

Figure 1. Water temperature during the experiment.

139 Pieces of wels (see Picture 1) were used, which were trained to artificial diet. Starting weight varied between 28.2-125.5 g, the distribution was normal (Dn=0.93; Dn(95%)= 1.36; n=139). First of all the stock was assorted according to individual weight. Three size classes were formed: „little" (m_{mean}±SD: 45.9±9.5g), „medium" (m_{mean}±SD: 54.1±15g) and „big" (m_{mean}±SD: 77.9±14.2g) class. 15-16 Individuals were held in each fish tank. Each of the size classes were involved in each of the treatments.

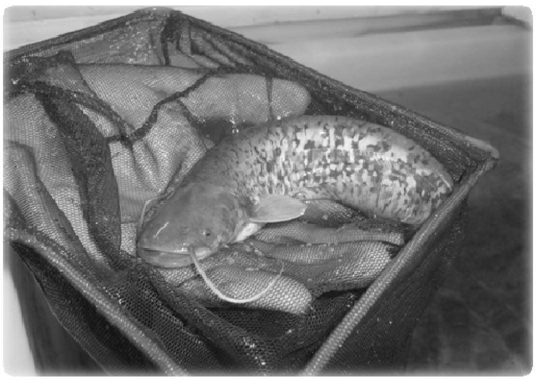

Figure 1. One of the experimental fish.

Three types of different treatments were set up. First group (W group) was fed with commercial wels feed (crude protein content 36%), second group (S group) was fed with squealer feed (crude protein content 20%), while the third group (S+F group) was fed with squealer feed and one day pro week with cutted forage fish. The squealer feed contains almost exclusively plant protein (mostly corn, wheat, soybean). *Ad libitum* hand feeding was applied, fish were fed three times a day. Each time as many granulate were offered as many the fish consumed immediately. Tiny cyprinids were served as forage fish.

Individual weight was measured weekly – biweekly with tenth gram precision. One day before measurements fish weren't fed. To avoid parasitic diseases a short, salty (2.5%) bath was applied during the measures. The body length of the individuals was also measured with 0.5 cm precision.

Food conversion ratio (FCR), daily absolute growth (G), specific growth rate (SGR) and condition faktor (K) were calculated. By the calculation of food conversion ratio the quantity of forage fish was corrected according to it's dry matter content (20%).

At the end of the examination 18 individuals were sacrificed. The weight of the torso, the liver, and the fat in the abdomen were measured.

Distribution functions were checked with Kolmogorov-Smirnov test. Compare of mean values was carried out with analysis of variance (ANOVA). Criteria of significance was determined 95 % probability ($p<0.05$).

Results and Discussion. At the end of the survey the distribution of individual weigths was normal (Dn=1.17; Dn(95%)= 1.36; n=120), which suggests that the treatments took equal effects on fish. Fight between individuals, diseases, mortality weren't able to seen during the examination. The total weight gain was the following in the certain treatments: W group: 7240.2 g; S group: 3599.3 g; S+F group: 4122.5 g. At the end of the examination the total weight gain was significantly higher in the W group. In this regard there wasn't any significant difference between S group and S+F group (ANOVA; df=10, F=0.001, p=0.97) (Figure 2).

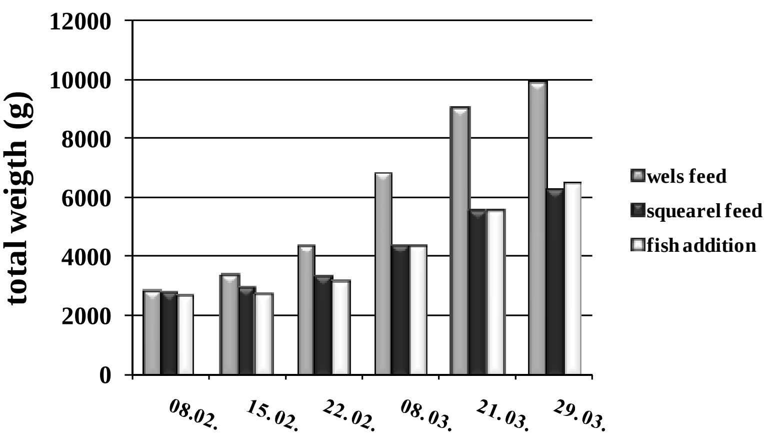

Figure 2. Total weight gain in the different treatments.

There were no significant differences in the starting mean weight inside any of the size classes (ANOVA, little: df=45, F=0.83, p=0.44; medium: df=43, F=0.093, p=0.91; big: df=42, F=1.92, p=0.16). At the end of the experiment the individual mean weight was significantly higher in the case of the W group in all of the three sizes classes (ANOVA, df=117, F=32.25, $p<0.001$). There wasn't any significant difference between the growing velocity of S group and S+F group (ANOVA; df=78, F=0.038, p=0.85) (Figure 3).

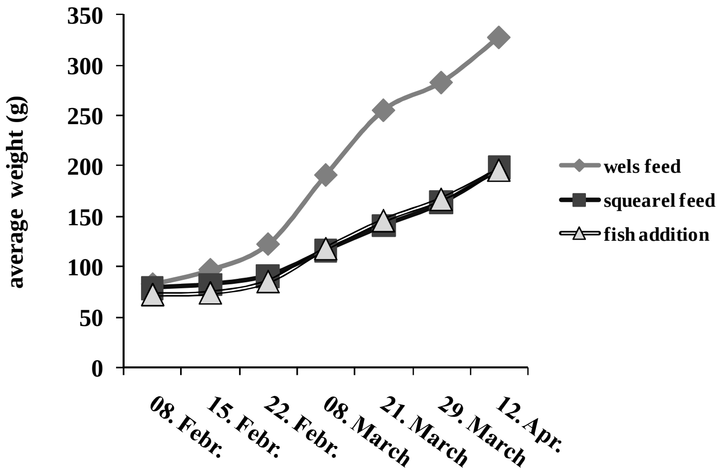

Figure 3. The average individual weight of wels in the „big" size class.

The condition of wels individuals was also better in the wels feed treatment (mean±SD; 0.72±0.02) than in the other two groups (0.62±0.02) (ANOVA; df=42, F=155.25, p<0.001). The condition of the S+F group significantly increased by the end of the experiment (ANOVA; df=10, F=1.17, p=0.27). There weren't any changes of condition in the case of the other groups. The regression between individual weight and individual body length is exponential and can be seen in Figure 4.

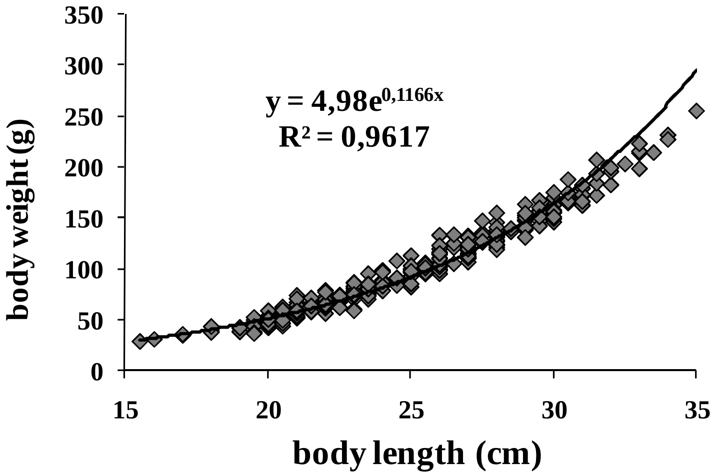

Figure 4. Regression between body weight and body length.

The absolute dial growth of the W group at the start of this survey was more than twofold higher (3.60 g day^{-1}) than in the other two groups (S group: 1.34 g day^{-1}; S+F group: 1.22 g day^{-1}). At the same time this value decreased progressively during the examination time (2.77 g day^{-1}). Whilst an increase was occured by the S group (2.56 g day^{-1}) and by the S+F group (2.73 g day^{-1}) (Figure 5).

Specific growth rate followed trends similar to individual absolue growth. SGR value varied between 0.89% (S group) and 4.60% (W group). At the starting point of the survey the growth of the individuals fed with wels feed was faster in all of the three size classes (Figure 6). By the end this value decreased to it's tierce. There weren't any significant changes in SGR in the case of S group and S+F group.

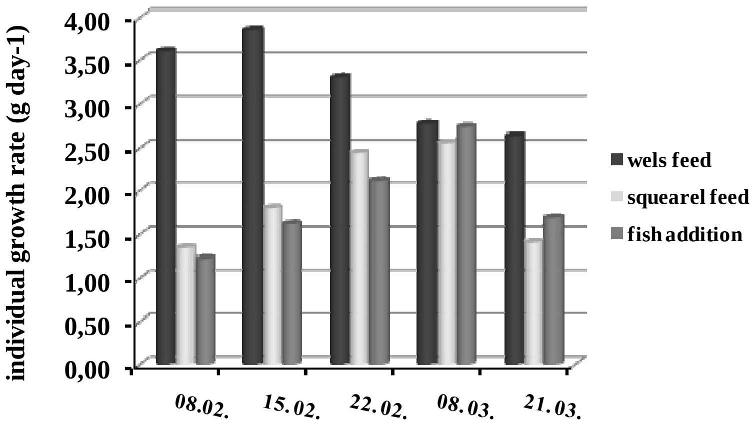

Figure 5. Dial absolute growth rate in the „medium" size class.

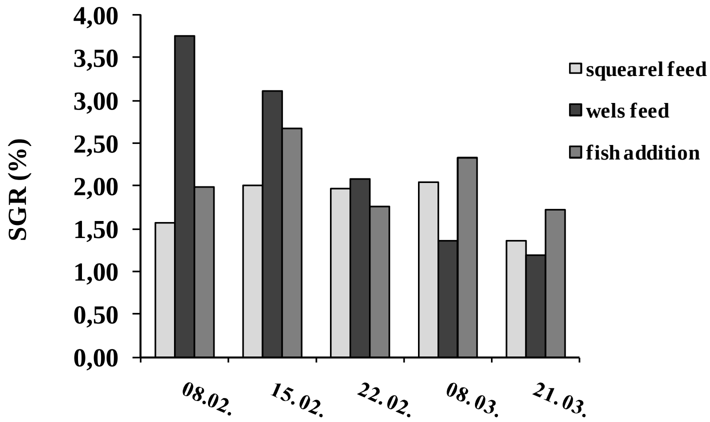

Figure 6. Changes of specific growth rate during the experiment in the „little" size class.

By the calculation of food conversion ratio the quantity of forage fish was considered according to it's dry matter content (20%). FCR was the lowest in the case of W group, and the worst in the case of the S group (Table 1). Food conversion declined in all of the treatments during the experiment.

Table 1

Food conversion ratio values during the experiment

FCR	*wels feed*			*squearel feed*			*fish addition*		
Nr. of fish tank	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
22. Febr.	0.64	0.65	0.67	1.54	1.60	1.64	1.21	1.37	1.25
08. March	0.68	0.68	0.67	1.58	1.57	1.54	1.29	1.34	1.27
21. March	0.88	0.91	0.84	1.83	1.67	1.94	1.70	1.53	1.68
29. March	1.17	1.13	1.15	1.56	1.89	2.29	1.47	1.54	1.48
12. Apr.	1.06	1.01	1.12	1.78	1.95	1.77	1.31	1.97	1.82
mean	0.88	0.87	0.89	1.66	1.73	1.83	1.40	1.55	1.50
dispersion	0.23	0.21	0.24	0.14	0.18	0.30	0.20	0.25	0.25

The autopsy results showed that the amount of the fat in the abdomen and the size of the liver were bigger in the case of the W group. This difference was multiple by the fat content (Table 2).

Table 2

Autopsy results in the proportion of body weight and body length

%	*torso*	*liver*	*fat*	*intestine (length)*
wels feed	64.5±1.8	2.3±0.3	4.1±1.0	71.4±10.4
squearel feed	64.1±2.0	1.8±0.3	1.0±0.8	59.7±6.5
fish addition	65.4±2.0	1.8±0.2	0.5±0.3	60.9±4.2

Conclusions. In our study it was shown that wels can be rear on plant protein based diet. Although the growth rate remained under the growth rate of fish fed by commercial wels feed. Fish health problems, mortality were not existed, fish were eating well the offered diet.

The high fat content of the abdomen and the excessive size of the liver can be indicative of health problems using the commercial wels feed on a longer duration. The increasing speed of gain indicates that continuing the examination for a longer time would provide better results in the case of the squealer groups. It is possible that the duration of this examination wasn’t enough for the enzyme system to adapt to the altarnative diet.

Further examinations are necessary to find a new feed which can improve the growth rate either. Our purpose is to improve the consistance of the squaler feed and try other dits based on plant protein or fermentation product protein in similar studies. There is a need to expand this survey towards pond cultures. According to our results we would like to substantiate a new type of intensive wels culture in pond cages.

A pond cage system involves the benefits of extensive and intensive fish culture systems either. Between these conditions feeding worse quality, cheaper feeds can also be profitable.

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Received: 05 November 2010. Accepted: 28 November 2010. Published online: 28 November 2010.
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How to cite this article:
Havasi M., Gorzás A., Lévai P., Merth J., Bercsényi M., 2010 Intensive rearing of wels (*Silurus glanis*) fed with plant protein based feed. AACL Bioflux **3**(5):347-353.