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THE APLICABILITY OF FEED MIXTURES IN BURBOT, *Lota lota*, FARMING

PRIMJENA KRMNIH SMJESA U UZGOJU MANJIĆA (Lota lota)

Z. Adámek

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SUMMARY

Burbot, Lota lota, belong among valuable fish species of the Czech fish fauna but due to their rare occurrence in recent period, they are considered as a threatened fish species. Besides this, burbot appeared to be quite resistant to the conditions of intensive farming which is giving a good opportunity of its controlled production. Thus the aim of our study was to evaluate their ability to ingest fish by-products in feed mixtures and to assess its growth performance under conditions of rearing units with respect to water temperature. The indoor and outdoor trials were performed in experimental aquaria and channel respectively. Fresh and dried by-products from the fish processing plant were mixed in a ratio 7:1 to create a paste consistence feed mixture, and supplemented with feed mixture ALMA Forellenfutter 41 Mehl-Mix 6156 (ALMA Kempten, FRG). Only this last mentioned feed mixture was applied in the outdoor farming experiment.

The indoor experiments were performed under two temperature regimes (19.5 ± 0.9°C and 14.7 ± 1.0°C). Both temperatures appeared to be too high for young burbot culture and resulted in weight losses and negative specific growth rates (SGR) after three-week experimental periods. Both weight loss and SGR declines were reduced in variants with feeds supplemented with ALMA mixtures. However, in the outdoor experimental culture over the winter period (4.3 ± 2.1°C), fish doubled their individual weight (from 28.6 ± 8.4 g to 59.4 ± 10.4 g) during November - April with the SGR value 0.42% · day^{-1}. Though burbot are able to tolerate even temperatures above 20°C, their food ingestion is not sufficient to cover their energetic expenses and fish loose their weight. This is why burbot culture seems to be much prospective only under conditions of low water temperature using cool spring water or over the winter period.

Key words: Lota lota, farming, growth, feed mixture

Doc. RNDr. Zdeněk Adámek, University of South Bohemia, Research Institute of Fish Culture and Hydrobiology, Laboratory Pohořelice, Videňská 717, 691 23 Pohořelice, Czech Republic.

INTRODUCTION

The importance of burbot (Lota lota) for stocking purposes in Czech natural waterbodies resulted in quite well elaborated technologies of its reproduction (Holicky, Kubiček, 1980, Kouřil et al., 1985, Křivanec, Novotný, 1986, Průcha, 1988, Pokorný, Adámek 1997). Similarly, satisfactory results have been achieved in its culture in earthen channels and small ponds (Holicky, Kubiček, 1980, Mareš, 1991). However, the application of these technologies is connected with extremely high losses during this culture due to the problems with larvae feeding after their transition on exogenous nutrition.

Quite promising results in the culture of 0+ burbot, which are known to possess a good growth performance and amazing ability to adapt upon the environmental conditions, led to the experimental burbot culture in intensive farming units (Adamek et al., 1996). The aim is to achieve the marketable size during the first two years of their life because it is known that burbot growth is most rapid during this period (Yang et al, 1989). Since the third year when their sexual maturation starts (Sandlund et al., 1985), the growth of burbot is slower due to the gonad formation and their condition determinants are poorer (Pulliainen, Korhonen, 1990).

From these reasons, the attention was concentrated upon the possibilities of application of artificial feed mixtures in recent studies dealing with the prospects of burbot farming from advanced fry to yearling (Mareš, 1991). Thus the aim of our experiments was to complete the knowledge about applicability of by-products from fish processing plant with respect to burbot temperature requirements.

MATERIAL AND METHODS

Three indoor and outdoor experiments were performed during winter and early spring periods. Burbot utilised in the experiment originated from late December artificial stripping and following pond farming at RIFCH Vodnany - they were 0+ age category (6.6 - 14.3 g and 14.9 - 53.8 g for indoor and outdoor experiments respectively).

Feed mixture applied in indoor 110 L aquarium experiments was composed of fresh ground freshwater fish by-products mixed with dried fish wastes (Table 1) from fish processing plant. Both components were mixed in the ratio 7:1 to create a paste consistence feed mixture (feed A). The feed B was formulated by supplementation with feed mixture ALMA Forellenfutter 41 Mehl-Mix 6156 (ALMA Kempten, FRG). The diet formulation is presented in Table 2. During the experimental feeding, both feeds were stored deep-frozen at -18°C. The experimental aquaria were stocked with 5 fish in two replicates under two different temperature regimes - 19.5±10.9°C and 14.7±1.0°C and lasted for 19 and 22 days respectively.

Table 1. Biochemical composition of dried wastes from fish processing

Tablica 1. Biokemijski sastav suhih sporednih proizvoda pri preradi ribe

Component % - Sastojak	%
Dry matter - Suha tvar	96.89
Protein - Bjelančevina	28.60
Fat - Mast	19.47
Ash - Pepeo	7.93
Fibre - Vlaknina	2.83

Table 2. Feed mixtures composition (in % fresh weight) applied in experimental indoor culture (A and B mixtures) and in channel farming (A mixtue)

Tablica 2. Sastav krmnih smjesa (u % svježe mase) primijenjenih u zatvorenom pokusu (A i B smjesa) i uzgoju u kanalima (A smjesa)

Component/Mixture Sastojak/Smjesa	A	B
Fresh Fish By – Products Svježl riblji sporedni proizvodi	86.15	78.99
Dried Fish Wastes Suhi riblji sporedni proizvodi	13.85	12.68
Alma Forellenfutter 41 Alma – hrana za pastrve 41	0	8.34

Table 3. Physico-chemical determinants (mean ± ± S. D.) of the environment in the farming channel

Tablica 3. Fizikalno-kemijski pokazatelji ($\bar{x}$ ± S. D.) okoliša pri uzgoju u kanalima

Flow rate - Protok	$l.s^{-1}$	2.5 ± 0.7
Temperature	°C	4.3 ± 2.1
DO	$mg.l^{-1}$	12.3 ± 5.5
PH		7.79 ± 0.29
BOD_5	$mg.l^{-1}O2$	3 ± 1
COD_{Cr}	$mg.l^{-1}O2$	11 ± 9
Suspended solids Suspendirane čestice	$mg.l^{-1}$	3
NO_3^-	$mg.l^{-1}$	25.2 ± 3.8
NO_2^-	$mg.l^{-1}$	0.03 ± 0.02
NH_4^+	$mg.l^{-1}$	0.48 ± 0.56
PO_4^{3-}	$mg.l^{-1}$	0.09 ± 0.05
P_{total}	$mg.l^{-1}$	0.15 ± 0.11

Only the feed A was applied in the outdoor experiment which was performed in the concrete channel (20 x 2.5 x 0.9 m) on the trout farm Skalni Mlyn (the River Punkva, Moravian Carst). The experiment lasted from 4 Nov until 25 April. Water inflow was adjusted on 2.7±0.7 $l.sec^{-1}$ what represents the passage time approx. 5 hours. Its physico-chemical determinants are presented in Table 3. The asbestos cement sheeting plate (2 x 2 m) was installed on 10 cm stands on the channel bottom as a shelter enabling burbot to hide. Feed was applied on one feeding site in 1 m distance from the shelter.

The specific growth rate (SGR) was calculated according to formula:

$$SGR\ (\% \cdot day^{-1}) = 100 \cdot (\ln W_t - \ln W_i)/t$$

RESULTS

The aquarium experiment under enhanced temperature lasted for 19 days and fish lost their initial weight in both variants (Table 4). Fish weight loss amounted to 27.9 and 3.7% under higher water temperature, and 6.7 and 5.8% under lower water temperature with feed mixtures A and B, respectively. All SGR values were negative. The declines of both fish weight and SGR were more pronounced in variants fed mixture A.

The channel farming of burbot over the winter period was run under conditions of quite constant water temperature 4.3±2.1°C. Fish losses amounted to 31.2% but actual fish kills were noticed only sporadically. On the other hand, burbot escapement was registered during spring channel draining though the outlet was protected very carefully. Farmed fish achieved 59.4 g on the average over the winter what corresponds to the SGR value 0.42%.day^{-1}.

Table 4. Burbot growth performance (mean ± S.D.) with two feed mixtures under two different temperatures

Tablica 4. Rast manjića ($\bar{x}$ ± S. D.) pri dvije krmne smjese na dvije različite temperature

Temperature	°C	19.5 ± 0.9		14.7 ± 1.0	
Days - Dani		19		21	
Feed mixture - Krmna smjesa		A	B	A	B
Initial weight - Početna masa	g	10.4 ± 2.1	10.7 ± 4.8	7.5 ± 2.3	10.3 ± 3.8
Final weight - Završna masa	g	7.5 ± 2.3	10.3 ± 3.8	7.0 ± 2.1	9.7 ± 3.4
Weight loss - Izgubljena masa	%	27.9	3.7	6.7	5.8
Specific growth rate - Specifični stupanj rasta	$\%.day^{-1}$	-1.71	-0.20	-0.31	-0.27

Table 5. Results of burbot channel farming over the winter period

Tablica 5. Rezultati uzgoja manjića u zimskom razdoblju

Stock - Nasad		Initial Početak	Harvested Izlov
n fish - Broj riba	ind.-kom.	141	97
Total biomass Ukupna biomasa	g	4038	5726
Individual weight Individualna masa	g	28.6 ± 8.4	59.4 ± 10.4
Total length Ukupna dužina	mm		219 ± 11
Specific growth rate Specifični stupanj rasta	%.day^{-1}		0.42

DISCUSSION

Experimental fish were fed paste-form feed mixture from fish processing by-products. This feed was chosen purposefully with respect to the fact that fish are an important item of burbot food under natural conditions. This was confirmed by food analyses of burbot from various waterbodies - the literature data mention e. g. fish (Dyk, 1952, Kirilov, 1988, Guthruf et al., 1990), fish eggs (Hartmann, Quoss, 1982, Dubois, Dziedzic, 1989), amphipods (Ryder, Pessendorfer, 1992), and fish plus benthic animals (Sandlund et al., 1985, Nagy, 1985). There is obvious that high-protein diet is very important for burbot nutrition. An immediate reaction of burbot upon the mixtures supplied, which was easy to register visually, give the evidence about the role of smell in burbot feeding strategy and biology.

According to Mareš, 1991 burbot preferred soft feed particles, like tubicids, grated beef heart and eggs of cyprinids. On the other hand, their reluctance to ingest hard pelleted feeds was very obvious. As demonstrated in our experiments, the incorporation of pelleted feeds into ground fresh fish meat may be a possible way how to make them available to burbot.

Young burbot (and probably also adult fish) have strongly developed photophobia. Although they are able to adapt upon the conditions of permanent daylight, it is more suitable to enable them to hide under large plates, stones or similar shelters (20-25 cm plastic tubes). With respect to the night feeding activity of this species, it seems to be more convenient to supply the bigger portion of daily feed ration in late afternoon. It was always completely consumed overnight. Mareš, 1991 did not register burbot photophobia in his aquarium experiments and mentions that young burbot ingested food also under full lightening. This confirms that burbot is a very adaptable fish and may be they do not require to hide for successful farming results. Anyway, the hiding instinct and resulting effort to hide is so strong in fish grown previously under conditions of shelter availability, that they damage and injure themselves when trying to conceal from light in corners etc.

Daily food ration is not influenced by water temperature so considerably like in other fish species and should be approx. 5% of stock biomass with respect to fish adaptation and feeding activity. On the contrary to generally accepted idea, burbot are able to tolerate quite high temperatures. In our experiments, burbot ingested food even at temperatures about 20°C but its intake was not sufficient to cover the energetic expenses and fish lost their weight. Mareš, 1991 registered feeding activity even at 27°C.

Temperatures above 14°C cause probably increase energetic expenses resulting in growth stagnation and/or even weight loss. Pulliainen and Korhonen, 1990 observed this phenomenon also in a natural environment. In their opinion, burbot consume their energetic deposits during warmest summer periods. On the other hand, cold year periods seem to be very prospective for successful burbot farming. Fish growth performance and condition were very good in experimental channel farming over winter. Burbot doubled their weight from 28.6g to 59.4 g during 173 days from October till April. Winter weight growth of burbot under pond conditions is presented also by Holicky and Kubiček, 1980. Burbot (22 g) which were stocked into the pond in October grew to 67 g in spring, than to 112 g over summer period and finally to 240 - 370 g over next winter.

Burbot "mortality" amounted to 31.2% over the winter period. However, the main reason of quite high fish losses during the channel farming over the winter period was not any enhanced mortality but

burbot escapements with water during draining the channel. Young burbot are known to posses an extraordinary tendency to escape with discharged water not only when draining but also during the growing season (Holicky, Kubiček, 1980, Mareš, 1991). Although the channel outlet was checked very carefully during draining burbot found some tiny slots and escaped as some of them were observed downstream the outlet channel.

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SAŽETAK

Manjić, Lota lota, spada među korisne vrste češke ihtiofaune, međutim zbog smanjenog broja jedinki u posljednje vrijeme smatra se ugroženom ribljom vrstom. Manjić je prilično otporna riba pa je stoga pogodan za intenzivni uzgoj. Stoga postoji mogućnost za njegovu kontroliranu proizvodnju. Cilj istraživanja je bio utvrditi mogućnost hranidbe manjića sporednim ribljim proizvodima u krmnoj smjesi, te utvrditi njihov rast

obzirom na temperaturu vode. Pokusi su provedeni u akvarijima i kanalima što znači u otvorenim i zatvorenim uvjetima uzgoja. Riba je hranjena svježim i sušenim sporednim ribljim proizvodima u odnosu 7:1 kako bi se dobila ljepljiva konzistentna smjesa kojoj je dodana hrana za pastrve Alma Forellenfutter 41 Mehl-Mix 6156 (Alma Kempten, FRG). Pastrvska hrana korištena je u hranidbi manjića koji se uzgajao u otvorenim uvjetima uzgoja.

Istraživanja u zatvorenim uvjetima uzgoja provedena su u dva različita temperaturna uvjeta (19,5 ± 0,9° C i 14,7 ± 1°C. Nakon tri tjedna istraživanja za obje temperature je utvrđeno da su previsoke za uzgoj mlađa manjića, što je rezultiralo gubitkom tjelesne mase, te negativnom specifičnim stupnjem rasta (SGR). Opadanje tjelesne mase i specifičnog stupnja rasta utvrđeno je i u tretmanima u kojima je riba hranjena s ALMA krmnom smjesom. Tijekom zimskog razdoblja i uzgoja riba na otvorenom (u kanalima) pri temperaturi vode 4,3 ± 2,1°C ribe su u razdoblju studeni - travanj udvostručile tjelesnu masu (sa 28,6 ± 8,4 g do 59,4 ± 10,4 g), a dnevne SGR vrijednosti bile su 0,42%. Unatoč tome što manjić podnosi i temperature preko 20°C uzimanje hrane na tako visokim temperaturama nije dovoljno da pokrije njihovu energetsku potrošnju, te stoga gubi tjelesnu masu. Iz navedenih razloga manjić ima bolju perspektivu uzgoja pri niskim temperaturama vode tj. tijekom proljeća i zime.