ROLE AND SIGNIFICANCE OF ZOOPLANKTON IN SEMI-INTENSIVE CARP PRODUCTION

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ULOGA I ZNAČAJ ZOOPLANKTONA U POLUINTENZIVNOM SISTEMU GAJENJA ŠARANA

Apstrakt

Jedan od svetski najzastupljenijih sistema za gajenje riba je poluintenzivni sistem koji čini više od 80% (Tacon and De Silva, 1997). U najtradicionalnijem obliku, prisutnom uglavnom u Aziji, veći deo nutritivnih potreba riba se zadovoljava iz prirodne hrane, prisutne u jezeru, dok se manji deo zadovoljava kroz dodatnu hranu. Osnovna ideja ovog sistema je da se potrebe riba u proteinima zadovoljavaju konzumiranjem zooplanktona, zoobentosa i druge prirodne hrane, dok se energetske potrebe zadovoljavaju žitaricama i drugim lokalnim proizvodima u obliku dodatne hrane. Poslednjih godina u zemljama jugoistočne Evrope (Srbiji, BiH, Bugarskoj, Rumuniji) sve se više koristi peletirana i ekstrudirana hrana, umesto žitarica ili u kombinaciji sa žitaricama uz iskorišćavanje prirodne hrane iz samog ribnjaka.

Zooplankton predstavlja važanu prirodnu hranu za larve i odrasle stadijume mnogih vrsta riba koje se gaje u akvakulturi. On je i glavna prirodna hrana za larve i mesečnjake šarana, a zajedno sa faunom dna, predstavlja hranu za mlađ i gajenog konzumnog šarana. Zooplankton je značajan izvor proteina, amino kiselina, lipida, masnih kisenina, minerala i enzima (Kibria et al., 1997). U novim ribnjacima zooplankton je uglavnom poreklom iz vode za vodosnabdevanje, dok u starijim objektima, deo ovih organizama potiče iz banke trajnih jaja koja se nalaze u sedimentu, najčešće do dubine od 2 do 10 cm, odakle se jedan deo svake sezone razvija i prelazi u vodu. Razvitak zooplanktonskih organizama (Rotatoria, Cladocera, Copepoda), ima izraženu sezonalnost, pa je maksimum produkcije karakterističan za maj i jun (Paterson, 1993). Na žalost, tokom letnjih meseci (jul i avgust), kada postoje optimalni temperaturni uslovi za rast šarana, najčešće se javlja značajan pad uglavnom svih grupa zooplanktona a naročito kladocera i kopepoda. Ovaj pad u produktivnosti je pre svega rezultat sezonalnosti zooplanktonskih organizama a može biti i posledica velikog pritiska riba na zooplankton u uslo-

vim gustog nasada riba. Do izvesne mere se produkcija prirodne hrane može podstaći upotrebom veštačkih đubriva ili stajnjaka, koji zapravo dovode do porasta produkcije fitoplanktona koji je osnov ishrane za zooplanktonske organizme.

Larve šarana mogu da konzumiraju manje oblike zooplanktona kao što su rotatorije i nauplius larve kopepoda. Sa porastom, šaran počinje da konzumira krupnije oblike kladocera i kopepoda, a potom i organizme faune dna, hironomide i oligohete. Za šarana i druge vrste Teleostea, krupniji oblici zooplanktona, naročito krupne kladocere (*Daphni magna* i *D. pulex*) predstavljaju lako uočljiv plen, ne samo zbog dimenzija tela, već i zbog dobro pigmentisanog i krupnog oka. Osim toga, starije uzrasne kategorije šarana imaju tako razvijeni usni aparat koji je prilagođen za sakupljanje hrane koja je veća od 250 µm (Sibbing et al., 1986). Usled ovoga, na početku proizvodne sezone, na većini ribnjaka nasađenih sa jedno- i dvogodišnjom mlađi, vrlo brzo dolazi do istrebljenja krupnih zooplanktonskih organizama, što dovodi do dominacije rotatorija, larvi kopepoda kao i malih kladocera, kao što je *Bosmina longirostris*, jer više nema kompeticije za hranom.

U slučajevima kada postoji niska produkcija prirodne hrane, a ne postoji mogućnost đubrenja, usled npr. visoke temperature vode, dodatni objekti kao što su neupotrebljiva ribnjačka jezera, jame ili pak veliki tankovi, mogu poslužiti za dodatnu produkciju prirodne hrane – zooplanktonskih organizama. Masovna proizvodnja prirodne hrane na ovaj način može biti relativno jeftina posebno kada se kao đubrivo koristi stajnjak. Za manje količine zooplanktona, sakupljanje se može obaviti pomoću velikih planktonskih mreža zakačenih za čamac ili se mogu vući sa obale. Ukoliko su u pitanju veći objekti u kojima se gaji zooplankton, za sakupljanje se može koristiti adaptiran čamac po ugledu na "Baleen sistem" koji je poseduje deo koji zahvata vodu i mrežu za proceđivanje, nakon čega se organizmi propuštaju kroz seriju mrežica čime se raspoređuju po veličinskim klasama.

Razmatrajući svetski problem nedostatka vode i potrebe za održivom upotrebom vode i nutrijenata u akvakulturi neophodno je unapređenje dosadašnje prakse poluintenzivnog gajenja šarana. Prirodna hrana predstavlja obnovljiv izvor proteina, amino kiselina, masti i masnih kiselina, za gajene ribe i zato usavršavanje poluinteinzivnog sistema između ostalih mera unapređenja treba da ide i u pravcu njihovog većeg korišćenja bilo iz samih ribnjačkih objekata za gajenje šarana ili iz planktonskih jama, jezera ili tankova za njihovo gajenje. Na ovaj način će se omogućiti ekonomičnije iskorišćavanje prirodne hrane, a u kombinaciji sa optimalnom dodatnom hranom će nutritivne potrebe riba biti u potpunosti zadovoljene.

Ključne reči: *zooplankton, prirodna hrana, poluintenzivan sistem*

INTRODUCTION

Semi-intensive is one of the most practiced system for fish production in world, making over 80 % (Tacon and De Silva, 1997). There are different modes of intensification, but in the most traditional type of semi-intensive system, typically practiced in Asia, bigger share of the nutritional requirements of fish are met through the consumption of natural food, available in the pond, and to a lesser extent through consumption of supplementary feed of different quality. The basic idea is that the proteins requirements are mainly fulfilled from zooplankton, zoobenthos and other natural food and energy requirements are met though carbohydrates provided through row cereals and other locally available sources in the form of supplementary feed.

In recent years, in Southeast Europe (Serbia, BiH, Bulgaria and Romania), a shift towards a higher utilization pelleted and extruded feed instead of cereals or the combination of cereals and natural food from the fish pond has been in the scene.

Ecological patterns of zooplankton assemblages in fish ponds

Zooplankton has been recognized as an important source of natural food for both larvae and adults of many aquaculture species. Most fish and prawn species rely on zooplankton at some stage of their life span, and some are exclusively zooplankton feeders throughout their life. Zooplankton is the main natural food for larvae and fry carp (*Cyprinus carpio*), and together with zoobenthos are food for marketable size fish.

Zooplankton that inhabits earthen carp ponds in newly formed fish ponds usually originate from the water bodies used as water supply. In older fish ponds, a part of the zooplankton community comes from the egg bank deposits that form in the sediments, usually up to a few centimeters (2 – 10 cm) thick depending on the age of the pond.

Nutrients in carp ponds usually originate from various sources of water supply coming from adjacent rivers, lakes, canals, or other water resources as groundwater pumped from wells, from pond sediments, due to resuspension, or from applied agrotechnical measures. It has been shown that deep tube well water of certain characteristics, as high conductivity, low hardness and high concentration of ammonia nitrogen, can have a negative effect on zooplankton production, especially on Cladocerans, in aquaculture ponds (Dulić et al., 2011).

Zooplankton important as natural food for carp in natural and artificial water bodies has a pronounced seasonality, given that there is a maximum of development usually in May and June (Paterson, 1993). Unfortunately, during midsummer, when environmental conditions, as water temperature, are optimal for carp growth in fish ponds, there is usually a sharp depression in zooplankton production.

Feeding habits of carp

After the partial absorption of the egg yolk, 3 to 5 days after hutching, carp larvae start feeding exogenously on Rotifers and naupliar larvae of Copepods. After a short period of consuming these smallest zooplankters, carps move on to bigger pray, as Cladocera that are apparently a strong dietary preference particularly for carp up to one month old (Billard, 1999). Except cladocerans and copepods, juveniles and adult carp consume zoobentos, mainly Chironomids and Oligochaetes, but also young sprouts of aquatic plants.

Predation on zooplankton for adult carp is highly size selectable, with preferences for larger individuals, mostly big cladocerans, such as certain species of daphnids (*Daphnia magna* and *D. pulex*) as they are pigmented, so visible for carp. Additionally, Jha et al. (2006) reported a relative preference of carp and other cyprinides, towards Cladocerans, due to their slower locomotion compared to rather faster swimming Copepods. Due to this, at the beginning of the production season, in most ponds stocked with yearlings or adult carp, there is a rapid depletion of large zooplankton species, leading to a domination of Rotifers, copepod larvae and small cladocerans as *Daphnia longispina* and *Bosmina longirostris* since they are have no competitors for food resources.

Significance of zooplankton as nutritional food for carp

Zooplankton is a valuable source of proteins, amino acids, lipids, fatty acids, minerals and enzymes (Kibria et al., 1997). Carp larvae are rather incomplete organisms since organs, specially the digestive system, are still under development after hutching. However, fish larvae start with exogenous feeding before the yolk sac is totally depleted. This undeveloped type of digestive tract can digest only very simple food items as zooplankton organisms, and therefore poorly digest artificial diets (Hofer, 1995). It is assumed that enzymes of zooplankton can support the digestive process in larval gut (Kolkovski, 2001).

Dimension of feed particle that fish larvae can consume depend on the size of the mouth gape. Apparently the size of the mouth gape is in correlation with body size, and hence, this parameter depends on the egg diameter and the period of endogenous feeding (Dabrowski, and Bardega 1984). Feeding of juvenile and adult common carp, as it is mentioned earlier, consist of larger natural food organisms. Older carp are generally concerned to be benthvorous and facultative zooplanktivorous fish and their feeding apparatus is adjusted for collecting food items bigger than 250 μm (Sibbing et al., 1986). Large zooplankters as *Daphnia magna* and *D. pulex* are a very good source of proteins presenting up to 50% of their dry body mass, for older carp (Kibria *et al*., 1997). Apart from their size, for carps that are visual predators these zooplankton species present a noticeable prey even more due to the pigmented and large compound eye characteristic for genus Daphnia. On a whole fish pond experiment, surface ranging from 112 to 200 ha, it has been shown that when *D. magna* and *D. pulex* when comprising over 54% of the total content of the dominant Cladocera group in the pond, there has been a statistically significant ($p<0.01$) effect on growth rate of one and two year old carp (Dulić, 2007). However, in a research on the impact of fishery management on Cladoceran population, that used a sampling net of different mesh size as a preliminary selection method of cladoceran size, it has been hypothesized that carp of bigger biomass predate more intensively on larger daphnids (Prazakova, 1991).

In circumstances when there is a low production of natural food in the fish pond, and no possibilities for fertilization due e.g. high water temperature, adjacent unusable ponds or big tanks can be used for additional production of natural food organisms. Mass production of live food organisms can be rather cheap when maintained on organic manures. There is a lot of data on exploitation of live or dried zooplankton, as food for fish in aquaculture. For smaller amounts of zooplankton, harvest can be done with a large plankton net towed behind a boat, or pulled from shore. If bigger ponds are used for culturing zooplankton, a Baleen harvesting system (Zoothech, Australia) can be applied. It consists of a boat equipped with a dewatering screen after which organisms are graded through a series of sieves. Selective harvest of needed zooplankton species can be obtained by choosing appropriate mesh size (Lavens and Sorgeloos, 2006). Additionally, zooplankton, especially daphnids, can be grown abundantly in sewage and wastewater, and possibly can be grow on effluents from fish ponds. Further on, this can be a way to decrease the amount of water pollution coming from semi-intensive fish production.

CONCLUSIONS

Semi-intensive production is the main type of fish in the world. In the view of worldwide concern for sustainable usage of water in aquaculture, semi-intensive fish production is also under reconsideration. In this production system the dietary requirements of the cultured species are obtained by feeding on natural food organisms available from the pond, and through direct consumption of supplementary feed (Tacon and De Silva, 1997). Natural food is a renewable resource and a very valuable source of proteins, lipids, amino and fatty acids, minerals and enzymes for cultured fish (Kibria et al., 1997). Improvements should be made toward a more comprehensive usage of natural food, either in the fish ponds or in additional ponds and tanks, as a cheap way to provide proteins of high quality. Still, a good balance between natural food and good quality supplementary feed should be made in order to fulfill all the nutrient requirement of cultured fish on one hand and to preserve the environment from pollution due to overload by uneaten additional feed.

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