COMMON CARP AND AQUACULTURE

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ŠARAN I AKVAKULTURA

Apstrakt
Akvakultura je najbrže rastući sektor za proizvodnju hrane od životinja. Njena stopa rasta od 1970. godine je 8.3% godišnje sa 52.5 miliona tona (2008; 68.3 uključujući i vodene biljke) i odgovorna je za skoro polovinu ukupnih zaliha ribe za ishranu (SOFIA, 2010). Riblje ulje i riblje brašno se tradicionalno koriste kao sastojci u ishrani karnivornih ribljih vrsta. Riblje ulje ima visok nivo n-3 polinezasićenih masnih kiselina (n-3 PUFA; 20 i više ugljenikovih atoma i 3 i više dvostrukih veza), naročito eikozapentaenoinske kiseline (EPA; 20:5n-3), dokozapentaenoinske (DPA; 22:5n-3) i dokozaheksaenoinske kiseline (DHA; 22:6n-3), prirodno je i hranljivo za ribe kao i za ljude. Kako se akvakultura razvija, ribljie brašno i ulje postaju skuplji i deficitarni. Zbog toga vremenom počinje da se vrši pritisak na proizvođače hrane za ribe da zamene ove sastojke sa više održivim alternativama (Pickova & Morkore, 2007). Obično se ulje i biljni proteini koriste kao “zamena” u ishrani. Biljna ulja mogu da zamene veliku količinu ribljeg ulja u ishrani mnogih vrsta riba a da pritom to ne utiče na rast ili efikasnost hrane. Ipak, mana ovih alternativa u ishrani je nedostatak n-3 PUFA. To znači da je hranljiva vrednost za ljude ovih gajenih ribljih vrsta smanjena. Nekoliko alternativnih izvora ulja koja se dobijaju iz jednoćelijskih algi, pelaških organizama i beskičmenjka dna koji sadrže visoki nivo n-3 PUFA su indentifikovani i testirani kao hrana za vodene organizme. Njihova cena je ipak veoma visoka da bi se koristili regularno u hrani za vodene organizme.
Šaran (*Cyprinus carpio*) je jedna od najčešće gajenih vrsta na svetu. U 2008. godini, u svetu je proizvedeno 2 987 433 tona, a u Evropi 144 747 tona (FAO, 2011). Šaran je ustanovljena gajena vrsta i konzumira se tradicionalno u Centralnoj Evropi. Šaran je svaštojed koji se hrani planktonom i bentosom kao i detritusom u prirodnim uslovima. U Centralnoj Evropi šaran se gaji u veštačkim zemljanim ribnjacima u kojima je proizvodnja zasnovana na proizvodnji planktona i bentosa, dok se kao dodaci koriste žitarice i ostala dodata hrana. U poredjenju sa karnivornim vrstama, digestivni sistem šarana

je adaptiran na ishranu koja sadrži više ugljenih hidrata. U Evropi, ciklus proizvodnje šarana traje 3 do 4 godine.

Postoje dva izvora n-3 PUFA za šarana koji se proizvodi u ribnjacima: i) prirodna hrana, plankton i bentos, koji su bogati n-3 PUFA i ii) n-3 PUFA koju šaran sintetiše iz alfa linoleinske kiseline (ALA). Postoje podaci da, za razliku od morskih riba, šaran može da na prirodan način pretvori ALA u n-3 PUFA (Zheng *et al.*, 2004; Tocher, 2003). Zbog toga je jako važno razumeti i povećati sposobnost šarana da sintetiše n-3 PUFA iz ALA da bi se sačuvao masni kvalitet ribe koja se koristi u ljudskoj ishrani i da bi se na odrziv način koristili izvori hrane za ribu. Stoga, gajenje šarana može da postane neto izvor n-3 PUFA odabirom ribe sa visokim aktivnostima enzima koji učestvuju u elongaciji i desaturaciji masnih kiselina.

Potrebe šaranu za n-3 i n-6 masnim kiselinama su relativno niske (0.5–1%) i mogu se zadovoljiti masnim kiselinama sa 18 C atoma biljnog porekla (Takeuchi 1996). Udeo ribljeg brašna u hrani gajenog šarana je nizak (5%) (Tacon & Metian, 2008), dok se riblje ulje čak ni ne dodaje. Zbog toga je zamena ovih sastojaka znatno lakša u ishrani šarana nego karnivornih vrsta.

Gajenje šarana dakle, može da predstavlja primer dugoročne održive proizvodnje u kojoj se ne oslanjamo na izvore ribljeg ulja i ribljeg obroka. Zahvaljujući prirodnom procesu lanca ishrane u ribnjacima, proces gajenja šarana pretvara 'izgubljene' hranljive materije (naročito azot i fosfor) u vodi u veoma vredno hranljivo meso. U centralnim delovima kontinenta gde ljudi imaju manji pristup morskoj ulovljenoj ribi organizmi koji pripadaju niskom trofičkom nivou su veoma vazan izvor vrednih n-3 PUFA. Takodje, šaran bogat omega 3 masnim kiselinama se može proizvesti zamenom aditiva u hrani koja se unosi u ribnjake pogačom od lana i repe. Ova strategija je zaslužna za proizvodnju šarana sa stabilnim nivoom omega 3 masnih kiselina.

Istraživanja o povoljnim efektima hrane za ribe su najčešće usmerena ka morskim ribama i školjkama. Zbog toga se EPA i DHA na pogrešan način zovu 'morske' masne kiseline ili masne kiseline od 'ribe'. U slatkim i slanim vodama mikroalge u velikoj meri sintetišu ove n-3 PUFA, koje se transportuju putem lanca ishrane kroz sisteme.

Započeta je saradnja sa institutom za eksperimentalnu medicinu IKEM, da bi se istražili efekti koje šaran u ishrani ima na kardio-vaskularne indekse pacijenata koji su podvrgnuti SPA tretmanu. Istraživan je uticaj korišćenja u ishrani šarana (šarana sa povećanim sadržajem omega 3 masnih kiselina) na pacijente posle operacije srčane revaskularizacije koji su podvrgnuti SPA tretmanu. Lipidi plazme, LDL holesterol i TG nivoi su bili znatno poboljšani kod grupe pacijenata koja je konzumirala šarana, za razliku od kontrolne grupe, koja je dobijala piletinu kao izvor proteina životinjskog porekla u ishrani.

Ključne reči: *Šaran, ishrana, DHA, lipidi, proizvodnja u ribnjacima*

Abstract

Aquaculture is the fastest growing animal-food-producing sector with a growth rate from 1970 of around 8.3% per year and with 52.5 million tons (in 2008; 68.3 including aquatic plants) and accounts for almost half of total food fish supply (SOFIA, 2010).

Fish oil and fish meal have been traditionally used as ingredients in aqua-feeds for carnivorous fish culture. Fish oil has a high level of the n-3 highly unsaturated fatty acids (n-3 HUFA; 20 and more carbons and 3 and more double bonds), especially eicosapentaenoic (EPA; 20:5n-3), docosapentaenoic (DPA; 22:5n-3) and docosahexaenoic

acid (DHA; 22:6n-3), being natural and nutritious for fish as well as for humans. As the aquaculture is expanding, fish meal and fish oil become more expensive and scarce. It consequently creates a high pressure on the aqua-feed producers to replace these ingredients with more sustainable alternatives (Pickova & Morkore, 2007). Generally, vegetable sources of oil and protein are used as "The replacement". Vegetable oils can replace substantial amount of fish oil in the diets of many fish species without affecting growth and feed efficiency. However, the drawback of these alternatives is the lack of n-3 HUFA and therefore compromising the nutritive value of farmed fish for consumers. Several alternative oil sources, derived from unicellular algae, pelagic organisms or benthic invertebrates containing high amounts of n-3 HUFA have been identified and tested in aquafeeds. Nevertheless, their prices are still too high to be commonly used in aquafeeds.

Common carp (*Cyprinus carpio*) is one of the most cultured fish species in the world. In 2008, the world and the European production was 2 987 433 tons and 144 747 tons, respectively (FAO, 2011). It is an established cultured species. Carp is consumed as a traditional food in central Europe. Carp is an omnivorous species feeding on plankton and benthos as well as detritus in natural conditions. Typical farming practice in Central Europe is artificial shallow earthen ponds in which the production is based on plankton and benthos production supplemented by cereals or other additional feeds. The digestive system of carp is adapted to a diet including more carbohydrates compared to carnivorous species. The production cycle in Europe usually takes 3-4 years.

There are two sources of n-3 HUFA in carp produced in ponds: i) the natural feed, plankton and benthos, being rich in n-3 HUFA and ii) the n-3 HUFA synthesized by carp from alpha linolenic acid (ALA). It has been reported that carps, in contrast to marine fish, are able to bio-convert ALA to n-3 HUFA (Zheng *et al.*, 2004; Tocher, 2003). It is therefore of interest to understand and maximize the ability of carp to synthesize n-3 HUFA from ALA in order to preserve the lipid quality of the fish as human food and for sustainable utilization of feed resources. Carp culture might therefore be suitable of becoming net producer of n-3 HUFA by selecting fish with high enzyme activities in FA elongation and desaturation.

Carp has also relatively low requirements for both n-3 and n-6 FA (0.5–1%) which can be fulfilled by plant 18 carbon FA (Takeuchi 1996). Inclusion of fish meal in carp culture is low (5%) (Tacon & Metian, 2008) and fish oil being even absent. Thus the substitution of these ingredients will be considerably easier for carp compared to carnivorous aquaculture species.

Carp culture might therefore be an example of long term sustainable production without relying on the supply of fish oil and fish meal. In addition, carp culture turns "lost" nutrients (especially N and P) in water into a highly valuable nutritious flesh by the natural food chain in the ponds. The low trophic levels are especially important source of valuable n-3 HUFA in central parts of continents where the populations have less access to marine fish from capture. In addition, omega-3 carp has been produced by changes in additives into the pond feeds such as rape- and linseed cakes. By this strategy, a production of a stable omega - 3 lipid profile carp has been enabled.

Studies on beneficial effects of fish intake are very often directed towards marine fish and shellfish. EPA and DHA are therefore misleadingly called "marine" fatty acids or "fish" fatty acids. These n-3 HUFA are to a large degree synthesized by microalgae, both in fresh- and saltwater and transported via the food chain in the systems.

Collaboration with the Institute of experimental medicine IKEM, to investigate the effect of carp on cardio-vascular indices of subjects in SPA treatment has been started. Influence of carp (carp with increased content of omega 3 fatty acids) consumption on patients after cardiac revascularization surgery during the follow up SPA treatment was studied. Plasma lipids, LDL cholesterol and TG levels improved significantly in the group of patients receiving carp compared to the control group receiving chicken as the animal protein dietary portion.

Keywords: Common carp, nutrition, DHA, lipids, pond production

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