

VEGETABLE OILS IN NUTRITION OF CYPRINID FISH SPECIES

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ULJA BILJNOG POREKLA U ISHRANI CIPRINIDNIH VRSTA RIBA

Apstrakt

Meso ciprinidnih vrsta riba predstavlja značajan izvor proteina, masti, vitamina i minerala u ishrani ljudi. Masti ovih ribljih vrsta su bogate nezasićenim masnim kiselinama (USFA), kako mononezasićenom (MUFA), tako i polinezasićenim (PUFA) masnim kiselinama. Navedene grupe masnih kiselina imaju mnogobrojne povoljne efekte na održavanje fizioloških procesa u organizmu, pa samim tim i na očuvanje zdravlja ljudi. Hemijski sastav mesa ciprinidnih vrsta riba, kao i masnokisleinski sastav istog su pod uticajem brojnih faktora, među kojima je ishrana jedan od najznačajnijih. Glavni izvor masti u hrani za ribe je dugo bilo riblje ulje, ali je zbog drastičnog povećanja proizvodnje ribe iz akvakulture, njegova dalja upotreba u istoj meri postala neodrživa. U zavisnosti od vrste ribe, kao izvor masti se sve više koriste ulja biljnog porekla, kao delimična ili potpuna zamena za riblje ulje u kompletnoj hrani za ribe. Ovaj alternativni izvor masti može imati i negativnih efekata na ribe iz akvakulture, pre svega jer su ulja biljnog porekla siromašna ili su potpuno bez n-3 visoko nezasićenih masnih kiselina (n-3 HUFA), dok je riblje ulje poznato kao jako dobar izvor pomenutih masnih kiselina. Ovaj problem je slabije izražen kod ciprinidnih vrsta riba, koje su omnivori ili herbivori i prema rezultatima dosadašnjih istraživanja imaju veće potrebe za n-6 nego za n-3 masnim kiselinama za optimalan rast i održavanje bitnih fizioloških funkcija. Biljna ulja koje se najčešće koriste u ishrani riba su sojino, laneno, ulje uljane repice, suncokretovo, palmino i druga ulja. Upotrebljavaju se u komercijalnim smesama za ishranu ciprinidnih vrsta riba, bez negativnog uticaja na proizvodne parametre, ali mogu nepovoljno uticati na masnokisleinski sastav mesa ovako hranjenih riba. Međutim,

najveći broj istraživanja o zameni ribljeg ulja uljima biljnog porekla je izveden na salmomidnim vrstama riba, pa su poželjna dalja ispitivanja o uticaju različitih vrsta ulja biljnog porekla na hemijski i masnokiselinski sastav mesa, kao i na zdravstveno stanje ciprinida. Meso ciprinidnih vrsta je uglavnom pogodnog hemijskog i masnokiselinskog sastava i predstavlja važnu komponentu u zdravoj ishrani ljudi. Sve navedeno ukazuje na neophodnost istraživanja o daljem unapređenju kvaliteta mesa ciprinidnih vrsta riba upotrebom kompletnih smeša, kako bi se zadovoljile nutritivne potrebe ovih vrsta, povećala proizvodnja po jedinici površine, dobila riba kao finalni proizvod što boljeg kvaliteta i postigla dugoročna ekonomska održivost i zadovoljile potrebe potrošača. Pored toga, potrebno je kontinuirano vršiti promociju ribe gajene na ribnjacima Srbije kao nacionalog zdravog proizvoda poželjnog u svakodnevnoj ishrani ljudi.

Ključne reči: ciprinidne vrste riba, biljna ulja, lipidi, sastav masnih kiselina, ishrana

Keywords: cyprinid fish species, vegetable oils, lipids, fatty acid composition, nutrition

INTRODUCTION

Alongside with intensifying the production of cyprinid fish species, increasing attention is being paid to industrially produced fish feed. Large part of our research was focused on the changes in the chemical composition of the cyprinid fish meat and fatty acid composition of their muscles, which were the result of feeding with oils and other feedstuffs of vegetable origin, which proved to be very good in the nutrition of freshwater fish species. In the following text the possibilities of the use of oils of vegetable origin (VO) in the nutrition of the common carp and other cyprinid fish species will be highlighted. Moreover, the advantages and disadvantages of the implementation of these sources of fat into the feed for cyprinid fish species will be discussed.

CURRENT TRENDS IN FISH OIL USE FOR AQUACULTURE

Traditionally, raw fish has been used in fish feed production as a source of proteins and fat, but it is estimated that the demand for this raw material will exceed the possibilities of production in the next decade (Tacon and Metian, 2008). Despite increase in total world consumption of fish oil (FO) in aquaculture, the average share of FO in feed for particular species steadily decline (Tacon and Metian, 2008). The great number of previous studies, which more than two decades is dealing with this problem, certainly contributed to the above mentioned fact, but there is still a need to reduce consumption of this ingredient in order to preserve natural resources and to ensure economically sustainability of fish production.

REQUIREMENTS OF CYPRINIDS FOR ESSENTIAL FATTY ACIDS

Relatively low requirements for n-3 fatty acids in cyprinid fish species are related to low requirements in fats, which was proved in the grass carp (Du et al., 2008), tench (Ljubojević et al., 2014) and in other cyprinid fish species (Ćirković et al., 2012; Ljubojević et al., 2013a,b,c). Today, the requirements for only two fatty acids are determined: linoleic acid (LA, C18:2, n-6) and alpha linoleic acid (ALA, C18:3 n-3), which should make 1% of fats in

the carp feed (Takeuchi et al., 2002). The symptoms of essential fatty acid deficiency rarely develop in the common carp and include slower growth, high mortality and depigmentation of the skin (Takeuchi et al., 2002). Since the cyprinids need relatively little fatty acids of both the n-3 and n-6 series, it is supposed that they can be obtained from fatty acids of vegetable origin which contain 18 carbon atoms (Takeuchi et al., 2002).

CHALLENGES AND RESTRICTIONS CONCERNING THE USE OF VEGETABLE OILS

Every change in the fish feed which means the use of alternative components of vegetable origin must ensure normal growth. Thus, when choosing VO which is to partially or completely replace FO in fish feed, it is inevitable to consider its fatty acid composition. Thus, VO which is considered to be adequate source of fats in the feed should contain high levels of SFA and MUFA, which could be used as energy source, and low levels of LA because it is poorly oxidised and is difficult to be removed from the tissues with the use of the finisher. Moreover, the use of VO is challenging because the fact that they do not contain n-3 HUFA which are present in considerable amounts in FO. The content of n-3 HUFA in FO is about 20-30% of total fats, whilst VO contain only moderate levels of C18 PUFA, 18:3n-3. Besides, FO contain low percentage of n-6 PUFA, whilst VO are rich in C18 PUFA (Ljubojević et al., 2015).

INFLUENCE OF VEGETABLE OILS IN CYPRINIDS FISH FEED ON GROWTH PARAMETERS

Several studies have shown that total replacement of fish oil with vegetable oils in diets of cyprinid fish species, has no negative effects on fish growth and growth parameters (Turchini et al., 2007; Du et al., 2008; Zakęs et al., 2010; Ljubojević et al., 2014; 2015). Experiments conducted to date indicate that, when nutritional needs for essential fatty acids for omnivore species such as common carp, but also herbivores, such as grass carp are fulfilled, the use vegetable oils in feed for these species does not affect growth performance or the feed efficacy. In the majority of research the type of oil used as the source of fats did not influence the feed intake, which means that the lipid fraction of the feed has subtle influence on its palatability.

INFLUENCE OF VEGETABLE OILS IN CYPRINIDS FISH FEED ON PROXIMATE AND FATTY ACID COMPOSITION

According to results obtained by Turchini et al. (2007) and Ljubojević et al. (2014; 2015) total replacement of FO with VO in diets of cyprinid fish species, has no negative effects on fish proximate composition. Higher contents of LA and ALA in the fillets of cyprinid fish species fed feeds with VO were noted by Turchini et al. (2007). Ljubojević et al. (2014) reported that the intermediate gamma-linolenic (18:3n-6), eicosadienoic (20:2n-6), dihomo- γ -linolenic (20:3n-6) and eicosatrienoic (20:3n-3) acids were detected in tench fillets in all groups. Since VO are deprived of these fatty acids which are part of the biosynthetic pathways of n-6 and n-3 HUFA, this result features adaptive attempts to moderate HUFA deficiencies. A similar phenomenon was observed in common carp (Ljubojević et al., 2015).

The implementation of VO in the fish feed results in decrease of EPA, DHA and in the n-3/n-6 ratio, in comparison to the feed which contains FO, and has direct consequences on the nutritive quality of the final product. This is important from the consumers' viewpoint since the high contents of EPA, DHA and the n-3/n-6 ratio are connected with numerous favourable effects on human health and their decrease is considered to be unwanted. This implies that vegetable oils can be successfully used in cyprinid fish species as a source of fat in their feed. Given the results, the high price of FO and its tendency to oxidate and with consequential storage difficulties, it can be concluded that all of the assessed vegetable oils showed satisfactory effects and that the use of each is justifiable. When deciding on their use in cyprinids feed the choice should be based on their cost and availability on the market.

CONCLUSION

VO can serve as a useful source of lipids for cyprinid fish species and represent a suitable source of energy and essential fatty acids. The production performance of VO fed cyprinids is very often unchanged. The usage of VO in cyprinid fish species nutrition is still limited due to possible disorders in fatty acid flesh composition. Using VO as partial or total replacement of animal origin fat sources can further improve productivity and nutritive value of cyprinid fish species. Generally, cyprinid fish muscles have a favourable fatty acid composition and should be regarded as healthy products in human nutrition.

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REFERENCES

- Ćirković, M., Ljubojević, D., Đorđević, V., Novakov, N., Petronijević, R., Matekalo-Sverak, V., Trbović, D. (2012): The Breed Effect on Productivity and Meat Nutrient Composition of Fish. *Kafkas Universitesi Veteriner Fakultesi Dergisi* 18, 5, 775-780
- Du, Z.Y., Clouet, P., Huang, L.M., Degrace, P., Zheng, W.H., He, J.G. (2008): Utilization of different dietary lipid sources at high level in herbivorous grass carp (*Ctenopharyngodon idella*): mechanism related to hepatic fatty acid oxidation. *Aquaculture Nutrition* 14, 77-92.
- Ljubojević, D., Trbović, D., Lujić, J., Bjelić-Čabrilo, O., Kostić, D., Novakov, N., Ćirković, M. (2013a): Fatty Acid Composition of Fishes from Inland Waters. *Bulgarian Journal of Agricultural Science, Supplements* 19, 1, 62-71.
- Ljubojević, D., Ćirković, M., Novakov, N., Jovanović, R., Janković, S., Đorđević, V., Mašić, Z. (2013b): Productivity and Meat Nutrient in Fish: The Diet Effect. *Kafkas Universitesi Veteriner Fakultesi Dergisi* 19, 1, 43-49.
- Ljubojević, D., Ćirković, M., Đorđević, V., Puvača, N., Trbović, D., Vukadinov, J., Plavša, N. (2013c): Fat quality of marketable fresh water fish species in the Republic of Serbia. *Czech Journal of Food Sciences* 31, 445-450.

Ljubojević, D., Ćirković, M., Novakov, N., Puvača, N., Aleksić, N., Lujčić, J., Jovanović, R. (2014): Comparison of meat quality of tench, *Tinca tinca*, reared in extensive and semi-intensive culture systems. *Journal of Applied Ichthyology* 30, 50–57.

Ljubojević, D., Radosavljević, V., Puvača, N., Živkov Baloš, M., Đorđević, V., Jovanović, R., Ćirković, M. (2015): Interactive effects of dietary protein level and oil source on proximate composition and fatty acid composition in common carp (*Cyprinus carpio* L.). *Journal of Food Composition and Analysis* 37, 44–50.

Tacon, A.G.J., Metian, M. (2008): Global overview on the use of fish meal and fish oil in industrially compounded aquafeeds: Trends and future prospects. *Aquaculture* 285, 1-4, 146-158.

Takeuchi, T., Satoh, S., Kiron, V. (2002). Common carp, *Cyprinus carpio*. *Nutrient Requirements and Feeding of Finfish for Aquaculture*, 245-261.

Turchini, G.M., Moretti, V.M., Mentasti, T., Orban, E., Valfre, F. (2007): Effects of dietary lipid source on fillet chemical composition, flavour volatile compounds and sensory characteristics in the freshwater fish tench (*Tinca tinca* L.). *Food Chemistry* 102, 1144–1155.

Zakęś, Z., Jankowska, B., Jarmolowicz, S., Zmijewski, T., Partyka, K., Demska Zakes, K. (2010): Effects of different dietary fatty acids profiles on the growth performance and body composition of juvenile tench (*Tinca tinca* L.). *Reviews in Fish Biology and Fisheries* 20, 389–401.