IMPORTANCE OF FISH MEAL AND OTHER ANIMAL FEEDSTUFFS IN PRODUCTION OF CONCENTRATE MIXTURES

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ZNAČAJ RIBLJEG BRAŠNA I DRUGIH HRANIVA ŽIVOTINJSKOG POREKLA ZA PROIZVODNJU SMEŠA KONCENTRATA

Abstrakt

U radu je prikazan značaj ribljeg brašna kao i drugih hraniva životinjskog porekla za proizvodnju smeša koncentrata, kao i mogućnost njihove suspstitucije hranivima biljnog porekla u kombinaciji sa sintetičkim aminokiselinama, ili komercijalnim „zamenama" ribljeg brašna.

Riblje brašno je do sada najviše korišćeno hranivo životinjslog porekla. Zbog opasnosti od širenja bolesti *Bovine spongiform encephalopathy* – BSE, u Evropskoj uniji je regulativama 999/2001 i 1234/2003 zabranjena upotreba obrađenih animalnih proteina, u koje spadaju različite vrste mesno-koštanog brašna, za sve farmske životinje koje ulaze u lanac ishrane ljudi, izuzev ribljeg brašna za nepreživare. Kod nas je u skladu sa Zakonom o veterinarstvu iz 2005. uvedena obaveza za sve fabrike hrane za životinje da odvajaju linije u kojima se pripremaju koncentrati za preživare, ili da proizvodnju obavljaju na istoj liniji ali da se pri tome odreknu upotrebe hraniva životinjskog porekla. U skladu sa tim, vrši se stalni monitoring smeša za preživare.

Zadnjih godina je korišćenje ribljeg brašna u ishrani nepreživara jako smanjeno zbog navedenih zakonskih ograničenja, sve lošije hranljive i upotrebne vrednosti (zdravstvene ispravnosti), problema falsifikovanja (dodavanja hraniva niže hranljive vrednosti: sojine sačme, kukuruznog glutena, brašna od perja pa čak i uree) kao i zbog visoke cene. Osim toga, dobro je poznato da riblje brašno prenosi svoj specifičan miris na proizvode pa se obavezno isključuje iz smeša pri kraju tova brojlera.

Velike količine ribljeg brašna se i danas koriste pri proizvodnji peletirane hrane za pastrmke i druge karnivore ribe. Naime, ove vrste riba zahtevaju visok nivo proteina dobre biološke vrednosti u obrocima. Ranih 90-ih godina preporučivan odnos svarljivih sirovih proteina i svarljive energije u obrocima za pastrmke je bio 22-25 g/MJ. Nasuprot

tome, u zadnjoj dekadi eksperimentalno je dokazana efikasnost obroka sa većim sadržajem masti (>20%) i kada je odnos proteina i energije uži. Međutim, u tom slučaju treba obezbediti odgovarajući nivo esencijalnih aminokiselina. Objašnjenje je u specifičnom metabolizmu riba. Krajnji proizvod metabolizma proteina u riba je amonijak, za šta je potrebno manje energije. Nasuprot tome, krajnji proizvod metabolizma energije u svinja je urea, čime se objašnjava uži odnos proteina i energije (oko 14 g/KJ).

Zbog svega navedenog proizvođači teže da riblje brašno zamene (delimično ili potpuno) nekim drugim proteinskim hranivom (biljnog ili životinjskog porekla), pri čemu je jedan od glavnih ciljeva što niža cena proizvodnje. Do sada je najviše pažnje poklanjano proizvodima od soje, odnosno sojinoj sačmi. Ovo hranivo ima veliku biološku vrednost proteina ali i visok sadržaj različitih antinutritivnih materija. Nasuprot tome, efikasnijim se pokazao koncentrat proteina soje. To je hranivo koje se dobija uklanjanjem masti i rastvorljivih ugljenih hidrata. Eksperimentalno je utvrđena mogućnost delimične supstitucije ribljeg brašna suncokretovom sačmom, ali je glavni nedostatak ovog hraniva u velikoj količini nerastvorljivh ugljenih hidrata. Pored ovih hraniva, u eksperimentima su ispitivane sačme pamuka, kikirikija, uljane repice, brašno lupine, kukuruzni gluten, proteini krompira i dr. Međutim, nedostatak svih ovih hraniva je nizak nivo nekih esencijalnih aminokiselina kao i prisustvo antinutritivnih, štetnih i nesvarljivih materija. Jedno od potencijalnih proteinskih hraniva za ribe i domaće životinje je bakterijski protein. U pogledu brzine rasta i produkcije proteina, bakterije imaju prednost u odnosu na kvasce. Pored toga, bakterije sadrže i više proteina (do 80%), a aminokiselinski sastav je povoljniji i sličniji proteinima životinjskog porekla. Nedostatak je velika količina nukleinskih kiselina (do 18%) koje u sisara katabolišu do mokraćne kiseline.

U zaključku se ističe da su troškovi ishrane ključni za rentabilnost proizvodnje u stočarstvu i nekim oblicima ribarske proizvodnje. Supstitucija ribljeg brašna u obrocima za domaće životinje i ribe je neophodnost zbog visoke cene ovog hraniva, varijabilnog kvaliteta i eventualnog falsifikovanja jeftinijim hranivima. Za sada, najveći značaj pokazuju proizvodi prerade soje a određenu perspektivu imaju i bakterijski proteini.

***Ključne reči**: riblje brašno, hemijski sastav, sintetičke aminoksieline, supstitucija.*

INTRODUCTION

According to modern concepts for nonruminant nutrition, the amount of essential amino acids is the most important criteria in formulating concentrate mixtures, compared to the amount of total or "crude" protein content. Aside from that, modern normatives for dairy cows take into account amino acid profile of the ration, considering that their microbial synthesis is not sufficient (Grubić and Đorđević, 2005). Feeds of animal origin were used for decades as essential source of amino acids in mixtures for almost all species of animals. However, in recent times the use of such feedstuffs is banned in European Union in the nutrition of all farmed animals which enter the human consumption chain, aside from fish meal used in nonruminants, in order to prevent spreading of the "mad cow disease" - *Bovine spongiform encephalopathy* (Đorđević et al., 2009). The utilization of animal feeds today is mostly restricted to the use of powdered milk in milk replacers for young ruminants (Đorđević et al., 2007), while meat meal is used for production of extruded pet feeds. According to the Veterinary Law of 2005, it is mandatory in Serbia that feed mills which use fish meal have separate production lines for

mixing feeds for ruminants and nonruminants (Đorđević et al., 2010a). The production of mixtures for ruminants is regularly monitored according to this law (Nešić et al., 2010).

The possibilities to substitute fish meal and other animal feedstuffs

Feeds of animal origin are the main or secondary products of slaughterhouses, dairy, rendering industry and fish processing plants. They have high content of protein which may have variable biological value. Among these feedstuffs fish products have special place because of their high protein content with excellent biological value, and also high content of minerals and some vitamins. Fish and fish products are among least expensive feeds of animal origin. Because of that fresh fish was used for many years as feed for various animal species. However, due to the high risk of decaying fish and fish products should be conserved, which can be done by process of "ensiling" with direct acidification or stimulation of lactobacillus species, of which we poses or own results (Đorđević et al., 1998; 1999; 2000; Jokić et al., 2001). Fish conserved in such way have high moisture content and is not suitable for industrial production of concentrate mixtures. The other process, much more expensive, is fish drying and production of fish meal. Approximately 20% of the world's fish harvest is used for production of fish meal for animal feeding. In recent years the use of fish meal in nonruminant nutrition was reduced because of the explained lawful restrictions, and decreased nutritive and functional value (and health risks), problems with falsifying (adding feeds with lower nutritive value such as: soybean meal, maize gluten, feather meal and even urea), and also because of its high price. It is also well known that fish meal transfers specific odor on final products, and is excluded from concentrates in finishing broiler chick feeding (Đorđević and Dinić, 2007). This is why fish meal is today being replaced with combination of quality feeds of plant origin with added synthetic amino acids, or specific commercial products (Đorđević et al., 2010b). Such combinations can achieve similar nutritive value, with equal or even lower price (Đorđević et al., 2006).

High quantities of fish meal are used today in the production of pelleted feeds for trout and other carnivorous fish species. Such fish species require appropriate level of protein with high biological value in their diets (Đorđević et al., 2005). In the early 1990-s the recommended ratio of digestible protein and digestible energy in trout feeds was 22-25 g/MJ (Cho, 1992). However, during the last decade it was experimentally confirmed that diets with higher fat content (>20%) is more effective, when protein / energy ratio was narrower (Yamamoto et al., 2005). In such circumstances it is necessary to provide the appropriate level of synthetic amino acids. The explanation for that is in specific fish metabolism (Đorđević et al., 2005). The end product of protein metabolism in fishes is ammonia, and it requires less energy to produce than urea, which is produced in mammals, such as pigs, and that explains narrower protein / energy ratio (about 14g/KJ). Yamamoto et al. (2005) in their experiment with trout fry used diets with lower protein content and protein / energy ratio of 16-17 g/MJ, but the synthetic amino acids were added. It was confirmed that fish had better utilization of feeds and higher nitrogen retention when essential amino acids were added (table 1).

Table 1. Growth, feed performance and whole body proximate composition of rainbow trout (Yamamoto et al., 2005)

	A	B	C	D	P (anova)
Growth and feed performance					
Initial BW (g)	20.8±5	20.8±5	20.9±6	20.9±3	0.958
Final BW (g)	68.4±1.4	66.0±7.9	64.2±5.7	69.0±6.5	0.646
Gain, %	236±10	235±43	223±28	246±31	0.650
Feed intake, (%BW/day)	$1.91±0.09^{b}$	$1.80±0.09^{ab}$	$1.76±0.07^{a}$	$1.74±0.04^{a}$	0.026
DE intake (kJ/kg BW/day)	332±15	342±17	335±14	330±8	0.625
Feed efficiency	$0.94±0.03^{a}$	$0.99±0.06^{ab}$	$0.98±0.03^{a}$	$1.05±0.04^{b}$	0.016
N retention (%)	$35.4±1.5^{a}$	$44.4±3.1^{b}$	$44.5±1.8^{b}$	$49.7±1.6^{c}$	<0.001
Whole body proximate composition					
Moisture (%)	$69.3±0.5^{b}$	$66.6±0.5^{a}$	$66.1±0.6^{a}$	$66.5±0.2^{a}$	<0.001
Crude protein (%)	$16.6±0.2^{c}$	$15.8±0.1^{a}$	$15.9±0.2^{a}$	$16.1±0.0^{b}$	<0.001
Crude fat (%)	$12.1±0.7^{a}$	$15.5±0.4^{b}$	$15.7±0.6^{b}$	$15.1±0.3^{b}$	<0.001
Ash (%)	2.3±0.1	2.2±0.1	2.2±0.1	2.3±0.1	0.124

A = with fish meal (48%); B = with fish meal (35%) + non-essential amino acid mix (1.76%); C = with fish meal (35%) + non-essential amino acid mix (1.10%) + essential amino acid mix (0.74%); D = with fish meal (35%) + essential amino acid mix (2.25%)

Other feeds of animal origin (meat meal, poultry rendering meal, feather meal, blood meal and others) have also high protein content, but they are poorly utilized because of their unfavorable amino acid profile, and lower digestibility (Degani et al., 1997). Steffens (1994) discovered that fish meal in trout nutrition may be partially replaced with feather meal and poultry by-product meals, while for complete replacement it is necessary to add some essential amino acids (Lysine and Methionine).

Because of the explained reasons feed producers tend to replace fish meal (partially or completely), with some other protein feedstuffs (of plant or animal origin), and with the main concern for production price. The most consideration was given to soybean products, especially soybean meal. This feedstuff has high biological value of protein, but also high content of various anti nutritive substances. The most effective was soybean protein concentrate, which is produced by removing fat and soluble carbohydrates from soy grains (Montagne et al., 2001). For example, Kaushik et al. (1995) fed trout (starting mass 81±1 g) with protein sources such as fish meal, soybean meal, soy protein concentrate and casein. The substitution of fish meal with soy protein concentrate (33 and 100%) had no influence on body mass and utilization of feeds, while substitution with soybean meal and casein led to significant decrease in daily gain. It is experimentally confirmed that partial substitution of fish meal is possible with sunflower meal, but the main problem with this feedstuff is its high content of insoluble carbohydrates (Sanz et al., 1994). Some other feedstuffs were used in experiments, such as cottonseed meal, peanut meal, canola meal, lupine meal, maize gluten, potato proteins and others. However, the shortcoming of these feedstuffs is low level of essential amino acids and presence of antinutritive, harmful and indigestible substances (Đorđević et al., 2005). A possible potential source of protein for fish and other animals is bacterial protein (Aas et al., 2006). Đorđević and Dinić (2011) report that bacteria have certain advantages compared to yeasts. Also bacteria have higher protein content (up to 80%) and better amino acid profile, more similar to the profile of animal tissues. The problem is that such protein has high content of nucleic acids (to 18%) which are catabolised to uric acid in mammals.

CONCLUSION

Feed price is key factor in the production economy of all animal, including fishes. The substitution of fish meal in animal feeding is necessary considering the high price of this feedstuff, and also its variable and often unreliable quality. In the investigations conducted various feedstuffs of plant and animal origin were used to substitute fish meal. However, when they are used the care must be taken to provide optimal concentration of essential amino acids in concentrate mixtures. In practice it can be achieved by combining cheaper protein feedstuffs with synthetic amino acids (Lysine and Methionine on the first place). At this moment most promising appears to be soybean products and bacterial proteins.

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