COMPARISON OF THE NUTRITIVE VALUE OF WHEAT AND TRITICALE IN FISH DIET

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UPOREĐIVANJE NUTRITIVNIH VREDNOSTI PŠENICE I TRITIKALE ZA ISHRANU RIBA

Apstrakt

Žitarice predstavljaju osnovni izvor energije za ishranu ljudi i domaćih životinja zbog visokog sadržaja skroba i drugih ugljenih hidrata. Dominantu ulogu među njima imaju kukuruz, pirinač i pšenica. Demografska eksplozija uslovljava da se za ovu namenu, uključujući ishranu riba, sve više uključuju druge vrste žitarica među kojima je i tritikale.

Žitarice se prema nutritivnoj vrednosti i upotrebljivosti za ishranu domaćih životinja mogu rangirati sledećim redosledom: pšenica - tritikale - kukuruz - ječam – raž.

Tritikale (x *Triticosecale*) je hibrid pšenice (*Triticum* spp.) i raži (*Secale cereale* sa nizom poboljšanih kvantitativnih karakteristika u odnosu na roditelje. Tolerantnost na bolesti i nepovoljne agroekološke uslove omogućuju gajenje u područjima manje pogodnim za gajenje komercijalno značajnijih žitarica. Zrno tritikale prema ukupnom sadržaju proteina (do 20% suve mase) i pojedinih esencijalnih aminokiselina (posebno lizina) prevazilazi druge žitarice. Sem toga, karakteriše ga povećana iskoristljivost fosfora uslovljena višim sadržajem enzima fitaze. Zrno tritikale ima neznatno manju energetsku vrednost u poređenju sa pšenicom. Povećan sadržaj celuloze smanjuje njegovu svarljivost. Ekstrudiranjem i drugim termičkim postupcima moguće je izvršiti želatinizacija sirovog skroba i povećati stepen svarljivosti.

Veći broj istraživanja sprovedenim na šaranu (*Cyprinus carpio*), ukazuju na mogućnost delimične zamene pšenice i kukuruza, kao i ribljeg brašna, tritikaleom u smešama za ishranu šaranskih vrsta.

Ključne reči: akvakultura, pšenica, tritikale, ishrana riba
Keywords: aquaculture, wheat, triticale, fish nutrition

INTRODUCTION

A large part of the human population has improper nutrition, implying inadequate intake of high-quality foodstuffs, primarily those of animal origin. Fish is known for its high quality attributed to high levels of proteins, vitamins (A and D in particular), minerals, polyunsaturated fatty acids and other nutrients (Vladau et al., 2008). Due to the above, intensification of fish production is underway on a global scale. In contrast to open water catches, aquaculture involving fish farming as its major activity shows a continued growth tendency.

Cereals in feeds for fish (notably cyprinids) are used as major sources of energy due to their high content of starch and other carbohydrates. In 2010, maize, rice and wheat accounted for more than 90% of world cereal production (Anonymous, 2013). The three cereal crops provide subsistence and serve as the major source of feed for livestock. Therefore, minor cereals including barley, rye, millet and other crops such as triticale are increasingly used in livestock and fish feed formulations.

WHEAT AND TRITICALE – BASIC CHARACTERISTICS

Wheat (*Triticum* sp.) is the world's most common crop (grown on over 240 x 10^6 ha, with a production of 651 x 10^6 t in 2010). Wheat originates from south-western Asia. There are about 30 wheat species, with common wheat (*T.aestivum* 6n = 42) and durum wheat (*T.durum* 4n = 28) as the predominant ones. The high nutritional value of wheat grain (average content of carbohydrates 71%, proteins 13%, fats 2.5%, high amounts of minerals and vitamins, particularly B-complex vitamins) and relatively high resistance to changing agroenvironmental conditions are reasons for the dominant role of wheat in human diet and its importance in livestock feeds.

Triticale (x *Triticosecale*) is a crop species developed in the second half of the 19th century from a cross between wheat (*Triticum* spp.) and rye (*Secale cereale*). Combining the genomes of the two crops resulted in genotypes incorporating the high yield potential and quality of wheat and the tolerance of rye to unfavourable environmental conditions (primarily low temperatures and pathogens) (Janković et al., 2011). Early triticale cultivars contained high levels of antinutritional factors such as trypsin inhibitors. Breeding work has led to the creation of hybrids (mostly 2n = 42) exhibiting improvement in qualitative and quantitative traits in terms of decreased amounts of harmful substances, an increased protein level (up to 20% dry weight basis) and a favourable amino acid profile (Table 1.). Apart from its intended use as a livestock feed and, to a lesser extent, as a foodstuff in human diet, triticale grain has been increasingly used as a feedstock for biofuel production. The total world triticale production in 2010 was 13.2 x 10^6t (Anonymous, 2013).

Table 1. Average composition of some cereal feed grains (Anonymous, 2011)

	Triticale	Wheat	Barley	Sorghum
Available energy (MJ/kg as fed)	12.9	13.1	12.9	14.6
Crude protein (% as fed)	12.9	10.4	11.3	9.7
Lysine (% as fed)	0.44	0.31	0.38	0.20
Methionine (% as fed)	0.20	0.15	0.16	0.12
Threonine (% as fed)	0.42	0.29	0.37	0.27
Starch (% dry matter)	63	66	58	74
Non-digestible fibres (% dry matter)	15.9	15.9	21.3	12.7

WHEAT AND TRITICALE IN FEEDS FOR CYPRINIDS

According to their nutritive value and usefulness in livestock nutrition, cereal crops can be ranked as follows: wheat – triticale – maize – barley – rye (Przybyl and Mazurkiewicz, 2004). The nutritive value of cereal crops is assessed using a number of parameters, notably available energy, protein content and digestibility.

The energy value of triticale grain is slightly lower compared to wheat. Grain protein content in cereal crops shows high variation, depending on species, cultivar, cultural operations and agroenvironmental conditions. Cereal proteins generally have a low content of essential amino acids compared to some other crops (e.g. soybean). The average levels of proteins and some essential amino acids (lysine, in particular) are higher in triticale grain than in some other cereals (Table 1.). Moreover, triticale grain has high phosphorus use efficiency due to the high phytase content (Janković et al., 2011).

Digestibility of cereal grains is affected by total carbohydrates, primarily starch and fibre. In semi-intensive carp farming, cereals account for 35-45% of feeds on average, with their crude starch and fibre content being 60-70% and 2-5%, respectively. Crude starch digestibility in carp is about 70%, whereas fibre is generally non-digestible. Thermal processing (primarily extrusion) enables starch gelatinisation, increases starch digestibility (Ćirković et al., 2002; Jovanović et al., 2005) and improves protein use efficiency. Compared to other cereal crops, wheat meal shows the highest apparent digestibility in carp diet (Degani et al., 1997). A high fibre content (4% on average) reduces the digestibility of triticale grain (Janković et al., 2011).

Justification for the use of triticale in feeds for cyprinids has been confirmed in many studies. Vacha et al. (2007) evaluated the effect of different cereal crops on flesh yield and quality of common carp over a period of 8 months. Common carp were in their third year of life, and their average initial weight was 1.13 kg. The fish were cultured in four ponds using, respectively, natural food only (control group), maize, wheat and triticale. A decrease in yield and feed conversion ratio was observed in carp fed triticale in their diets compared to carp receiving wheat and maize (with no significant differences observed). The average percentage of n-3 PUFA (polunsaturated fatty acids) in carp muscles was 2.5% ± 0.36 for maize, 3.1% ± 0.39% for triticale and 3.38% ± 0.44 for wheat, suggesting a high nutritive value of triticale.

Fish meal is the primary source of protein in most fish feeds (Stanković et al., 2011). The stagnation of fish catches from open waters and economic reasons demand the use of other sources of protein. The use of triticale as a partial fish meal replacement has been justified. In a 50-day experiment, Mazurkiewicz (2009) analysed the body weight of carp diets containing different amounts of fish meal, legume-rapeseed mixture, triticale meal and rye bran (Table 2.).

Table 2. Experimental diets for market carp (Mazurkiewicz 2009)

		Diet			
Ingredient	(%)	I	II	III	IV
Fish	meal	12.2	7.7	5.1	2.5
Legume-rapesed	mixture	-	17.0	27.0	37.0
Triticale	meal	25.2	31.9	36.9	41.3
Rye	bran	45.0	24.0	12.0	-
Monocalcium	phosphate	-	0.8	1.4	1.6
Standard components in all diets: Yeast (8%), Erythrocyte meal (5%), Rapeseed oil (1%), Soy bean lecithin (0.5%), Premix[1] (1.5%), Vitazol AD_3EC[2] (%), Chalk (1.3%), Choline chloride (0.2%)					

[1] Polfamix W, BASF Ltd, Kutno Poland; BIOWET Drwalew, Poland

Table 3. Growth of carp body weight during rearing (Mazurkiewicz 2009)

Days of test	Weight (g)			
	I	II	III	IV
Start	970 ± 1.1	969.3 ± 5.8	972.3 ± 7.2	965.7 ± 9.3
10	1125.3 ± 4.0	1124.7 ± 15.9	1146.0 ± 18.7	1115.0 ± 26.2
30	1307.0 ± 19.2	1350.7 ± 32.1	1386.3 ± 29.4	1364.0 ± 27.1
50	1522.0 ± 29.6	1568.3 ± 42.6	1650.7 ± 40.3	1592.7 ± 50.1

Table 3. shows data on growth of carp body weight. The tested diets for market carp did not have a significant impact on the quantitative and sensory characteristics of the individual carp analysed. The results suggest the possibilities of substituting fish meal protein with plant protein.

CONCLUSIONS

Cereals serve as a major source of energy in both human and livestock nutrition due to their high content of starch and other carbohydrates. According to their nutritive value and usefulness in livestock nutrition, these plants can be ranked as follows: wheat – triticale – maize – barley – rye.

Triticale is a hybrid of wheat and rye bred for improved quantitative characteristics of its parents. The total content of proteins and some essential amino acids is higher than that of other cereal crops. Its tolerance to diseases and unfavourable agroenvironmental conditions ensures adaptability to regions less favourable for the cultivation of commercially important cereals. Research on carp suggests the potential to use triticale as a partial substitute for wheat, maize and fish meal in feeds for cyprinids.

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