EFFECT OF DIFFERENT EXTRUDED COMPOUND FEED ON AFRICAN CATFISH *(Clarias gariepinus)* PRODUCTIVITY, MEAT CHEMICAL AND TECHNOLOGICAL PARAMETERS

Mindaugas Paleckaitis, Vilija Buckiūnienė, Rima Trepenaitienė, Jolita Klementavičiūtė, Asta Racevičiūtė-Stupelienė, Vilma Šašytė, Ieva Kudlinskienė*

Institute of Animal Rearing Technologies, Lithuanian University of Health Sciences Veterinary Academy Lithuania, Tilžės str. 18, LT-47181 Kaunas

**Corresponding author: Mindaugas Paleckaitis*
Lithuanian University of Health Sciences, Veterinary Academy
phone/fax: +370 37 363505, e-mail: mindaugas.paleckaitis@lsmuni.lt

Abstract. Feed quality as well as nutrition is one of the most important exogenous factors affecting the chemical composition of fish, so the aim of this study was to evaluate the effects of dietary levels of extruded compound feed on African catfish growing dynamic and meat chemical and technological properties. A trial was conducted with 70 of African catfish, aged 10 weeks. The fish were divided into two groups, 35 fish in each group and fed with extruded compound feed X (where hydrolyzed protein was got from feathers) in control group and extruded compound feed Y (the hydrolyzed protein was got from feathers and pig bristle meals) in experimental group for 3 months. During the trial were evaluated African catfish performance parameters and meat quality indexes, which are described by technological properties and meat chemical composition. Meat color were evaluated by CIE–LAB method, according lightness (L*), redness (a*), yellowness (b*). The results of conducted trial showed, that during 111 days of growing the weight of African catfish in control group was by 23.23% higher and feed conversion ration – by 27.26% lower in comparison with the experimental group. No significant difference between the meat lightness L * and yellowness (b*) were observed, however, the redness of the meat surfaces a *, who is more desirable to fish buyers, was by 1.52 point ($P>0.05$) higher in the control group than in experimental group. Although the pH value of the live freshwater fish varies from 6.9 to 7.3, but in this study the mention parameter was 5.88 in control group and 5.53 – in experimental. By analyzing the technological properties of fish meat, were determined, that fish from the control group distinguish by higher water holding capacity in comparison to the experimental group. Also were determined, that fish meat of the experimental group had higher protein, content by 0.93%, also were 0.92% fattier, compared to the Control group ($P>0.05$). Therefore, it can be concluded that African catfish fed with extruded compound feed having hydrolyzed feathers' protein were characterized by better production parameters compared to those African catfish who were fed with extruded compound feed with hydrolyzed feathers and pig bristle meals protein, which showed good technological properties and nutritional value.

Keywords: African catfish, chemical composition, technological parameters

Introduction. The aquafeed industry has shifted its preference from fishery-based to plant-based feeds. Fish has high nutritional value, especially high biological value proteins and lipids, being marketed and consumed worldwide. Fatty fish has high concentration of n-3 fatty acids, which is often perceived by consumers as beneficial for human health (Ruxton et al., 2005). However, fish is highly perishable due to their pH which is close to neutral, presents high water activity, is rich not only in unsaturated fatty acids but also in free amino acids, and exhibits active autolytic enzymes, making it prone to microbial and oxidative degradation (Lougovois and Kyrana, 2005).

Due to the large amounts produced by the meat industry, as well as the high protein content and potential nutritional value, feathers and pig bristles are particularly interesting as a biomass resource (Gonzalo et al., 2016). Pig bristles consist primarily of keratin (90% or more), an insoluble protein packed with cross-linked fibres by disulfide bonds. Keratin is known for its high mechanical stability, insolubility and recalcitrance to degradation by common proteolytic enzymes such as trypsin, pepsin and papain (Jahan et al., 2010).

The geographic range of the African catfish (Clarias gariepinus) extends from Africa to south-east Asia. In the course of evolution, the species has adapted to unsupportive environmental conditions. In its natural habitat, the catfish is an omnivorous predator that feeds on zooplankton, arthropods, mollusks, fish, reptiles and amphibians (Vitule et al., 2006; Amisah et al., 2009). In fish farms, the African catfish easily adapts to pond conditions and has relatively low requirements regarding water quality. The main goal of intensive cultures is to produce catfish with the highest body weight within a short period of time, which can only be achieved under optimal conditions.

The increasing demand and consumption of the fish flesh from aquaculture pose certain requirements concerning its quality and nutritive properties. In the past decades, studies of fish feed and improvement of feed quality have contributed to the development of aquaculture and led to increase in the nutritive value of farmed fish. The chemical composition of fish flesh is affected by numerous factors, which can be divided into endogenous and exogenous. Endogenous factors include genetic parameters, fish size, sexual maturity and life cycle phase, while exogenous factors are microclimate, water quality, quality and amount of food and the time and frequency of feeding (Shearer 1994; Huss 1995; Tkaczewska et al. 2014; Wasiu et al., 2017). Nutrition, but primarily feed quality is one of the most important exogenous factors affecting the chemical composition of fish.

Nevertheless, the most important attribute of any product regardless of any production technology would appear to be its quality, which is directly dependent on consumer satisfaction or its overall acceptance based on the sensory considerations such as taste, flavor, aroma, and palatability. Generally, sensory attributes of flesh from animals differ from one species to another and even within species, for maturity and sex (Forrest et al. 2001); and the attributes can also vary depending on the chemical composition of products (Heinz and Hautzinger 2007). However, fish were subjected to many stressors during a production period cause drop muscular flesh quality (Roth et al., 2006; Refaey et al., 2017), leading to reduced consumption and causes great economic damage for producers in aquaculture industry (Olsson et al., 2003; Bjørnevik and Solbakken, 2010).

Several studies have been conducted to evaluate the adequate energy to protein ratio for fish (Webster, 1995; Hernandez, 2001; Ai, 2004). However, several factors could influence the determination of proper dietary protein to energy ratio, such as fish species and their natural feed habits, size of fish, diet formulation and the production system (Ai, 2004; Wang, 2013).

Rapid growth in aquaculture is mainly designed to support fish growth free from diseases, avoiding intensive antibiotic, pesticide and other chemical use. Excessive protection oriented antibiotic use can cause the development of antibiotic resistant microorganisms which create harmful effect to aquatic and human life. Nevertheless, little information exists with respect to the performance of growing fish and the chemical composition and meat technological properties from fish fed with extruded compound feed. This study aimed to evaluate the effects of providing increasing dietary levels of extruded compound feed on African catfish growing dynamic and meat chemical and technological properties.

Material and methods

The experiment was carried out in 2017, at the LUHS VA Institute of Animal Rearing Technologies - Aquaculture Laboratory. A trial was conducted with 70 of African catfish, aged 10 weeks. The fish were divided into two groups, 35 fish in each group and fed with extruded compound feed X (extruded compound feed supplemented with hydrolyzed protein from feathers) in control group and extruded compound feed Y (extruded compound feed supplemented with hydrolyzed protein from feathers and pig bristles) in experimental group. The composition of extruded compound feed was – wheat, fish flour, peas, rapeseed cake, rapeseed oil, hemoglobin, hidrolyzed protein, vitamin and minerals (ME 20.5MJ/kg, DM – 90%, crude protein – 42%, crude fiber 4%, crude fat – 12%, crude ash – 4%). All fish were kept under the same conditions. The total weight gain was calculated by Tacon (1990), which is derived from the weight of the catched fish minus the weight of the let in fish.

At the end of the trial (111 days of growing) from each group 10 African catfish (5 fish × 2 groups of fish = total of 10 fish) were selected and killed according to the recommendations for experimental animals.

Meat quality indexes were determined at the Laboratory of Meat Characteristics and Quality Assessment at Lithuanian University of Health Sciences. The amount of dry matter was measured by the automatic scale for humidity assessment Scaltec SMO – 01, drying samples at 105 ºC. Intramuscular fat content analysis was performed by Soxhlet method (ISO 1443:1973 Meat and meat products determination of total fat content). Protein amount was determinate according to Kjeldal method (LST ISO 937:2000), total ash from meat weight of the residue obtained after incineration at a temperature of (550±25) °C (ISO 936:1998 Meat and meat products determination of total ash). Meat pH (estimated with pH-meter INOLAB 3) (pH ISO 2917:1999 Meat and meat products measurement of pH). Meat color -by CIE – LAB method, estimated meats‘ indexes are: lightness (L*), redness (a*), yellowness (b*) (Minolta Chroma Meter 410). Meat drip loss is estimated according to meats‘ weight reduction while keeping it suspended in bags with nets in +4 °C temperature for 24 hours. Meat shear force by Bratzler method (1949) Cooking loss values were determinate by Schilling method (1966).

The acquired data of productivity, chemical composition and technological properties of the African catfish were processed using Microsoft Office Excel 2010. Arithmetic averages of characteristics and the deviations of the averages were calculated. The reliability of arithmetic averages difference (P) is determined according to the Student. The data are considered to be statistically significant when $P<0.05$.

Results and discussion

The only relevant information contributed by other authors (Polak-Juszcack, 2007; Skalecki et al., 2013) was that the water content of muscle tissue in various fish species is inversely proportional to the combined content of total protein, fat and crude ash.

The analysis of the total fish weight data (Table 1) showed, that at the beginning of the growth stage, the fish between groups differed slightly - only 1.90% ($P>0.05$). After the first phase, there was no significant difference either - the total weight of the control group was by 3.92% higher than the total weight of the experimental group ($P>0.05$). However, in later experimental periods were noticed a much larger difference in weight and progression of this indicator: - in stage 2 (after deduction of the initial difference in total weight among the groups - 1.90%) - 7.51% ($P>0.05$), in stage 3 - 21.6% ($P<0.05$), in stage 4 - 23.23% ($P<0.05$) although the fish were fed 9 days shorter.

When analyzing the intensity of growth and feed conversion in the control and experimental groups, in the first growing stage among the comparative groups it was still small - 5.69%, in the second stage it reached 18.44%, while in the third stage it was even 50.71% in the control group. Significant differences are also observed in the dynamics of fish growth intensity. In the 1st stage, the control group increased 13.06%, in stage 2 - 13.36%, and in stage 3 it was even 30.2%. The intensity of the growth of the fish in the experimental group in the first stage decreased by 9.57%, in stage 2 it was almost equal to 0.03% and in the third stage decreased by 12.45%. Analyzing the feed conversion data, we noticed that they were similar in the 1st feed stage, differed only in the 0.069 kg / kg yield (8.34%), in the 2nd stage, had already started to differ significantly of the control group - 0.164 (17.55%). In the 3rd stage higher - 0.671 (83.45%), while stage 4 again began to decline quite significantly - 0.301 (27.26%). The average of total feed conversion in the experimental group was 1.193 in the experimental group and 0.899 in the control group.

Table 1. **Total and average fish weight, g**

Feeding period Feeding days number	Fish numbers (n) and weight (g)				Average of fish weight, g	
	Control group		Experimental group		Group	
	n	Weight, g	n	Weight, g	Control	Experimental
Fish weight at the begging of the trial, g	35	6425	35	6303	183.57±41.39	180.49±49.68
After 30 days	35	13815	35	13273	394.71±120.14	379.23±106.06
After 60 days	35	22345	35	20245	638.43±208.04	578.43±157.53
After 90 days	35	34565	35	26445	987.57±271.60	755.57±243.06
After 111 days	33	39060	33	29245	1183.64±255.49	886.21±280.68

Table 2. **Effect of different extruded compound feed on African catfish growing intensity and feed conversion ratio**

Feeding stage (period)	Feeding, days	Weight of group, g		Compound feed consumption, g		Compound feed conversion ratio, kg/kg	
		Control	Experimental	Control	Experimental	Control	Experimental
1	30	7390	6970	6110	6244	0.827	0.896
2	30	8530	6972	7981	7657	0.934	1.098
3	30	12220	6200	9830	9148	0.804*	1.475*
4	22	6863	4572	7577	6423	1.104*	1.405*
*- data statistically significant at $P<0.05$							

The data in Table 3, showed that no significant difference between the meat lightness L * data were observed. However, the redness of the meat surfaces a *, who is more desirable to fish buyers, was by 1.52 point ($P>0.05$) higher in the control group than in experimental group.

Table 3. **Effect of different extruded compound feed on African catfish meat colour characteristics**

Colour characteristics	Control group	Experimental group
L*	54.77±5.30	54.94±2.21
a*	19.23±3.24	17.71±2.29
b*	13.14±0.68	13.35±1.28

The data of technological meat properties of African catfish is presented in Table 4. The pH value of the live freshwater fish varies from 6.9 to 7.3 depending on the species (Health and human Services, 2015). The pH of the aquatic meat is reduced due to the decomposition of glycogen and the formation of lactic acid (Susanto et al., 2011). Meat pH is an important quality indicator, which indicates the possibility of longer storage and some technological properties (Jukna et al., 2007). In this study for the meat pH the differences between the group were not detected.

The meat drip losses depend on many of the possibilities - the animal's living environment (land or aquatic animals), species, breed and age, feed composition and other properties. The meat water holding capacity also depends on many factors, especially the freshness of the meat. This property is very important from a culinary point of view, since well-watered meat does not produce much juice (Barton-Garde and Bajerholm, 2001). Baking and cooking losses are also a very important indicator of the loss of meat weight during heat treatment. While baking and cooking also results in a loss of a significant proportion of vitamins and some minerals, the absorption of heat-treated fish protein and iron in the human body is better (Severi et al., 1997).

The data shows that cooking losses and water holding capacity in experimental group was by 3.00% and 4.24% respectively lower compared with control group.

Table 4. **Effect of different extruded compound feed on African catfish meat technological properties**

Meat technological properties	Control group	Experimental group
pH	5.88±0.08	5.53±0.06
Drip losses, %	4.06±2.46	4.39±3.28
Water holding capacity, %	64.25±3.94	61.25±2.98
Cooking losses, %	21.98±3.46	17.74±3.20

From a nutritional point of view is very important and meat protein and fat content. The chemical composition of African catfish is presented in a Table 5. Polak-Juszczak (2007) determined the total protein content of African catfish fillets at 17.90%, free fat content at 5.30%, crude ash content at 0.98% and water content at 75.53% (Chwastowska et al., 2016), and similar results were noted in our study.

Table 5. **Effect of different extruded compound feed on African catfish meat chemical composition**

Parameter	Control group	Experimental group
Dry matter, %	24.54±1.30	26.48±1.58
Intramuscular fat,%	6.65±0.99	7.57±1.61
Ash, %	0.98±0.21	1.07±0.06
Protein, %	16.91±0.72	17.84±1.31

The data in Table 5 shows, that the fish meat of the experimental group had higher protein, content by 0.93%, also were 0.92% fattier, as well the fish meat of the experimental group had 1.94% more dry matter, compared to the Control group (P>0.05). Therefore, it can be argued that the influence of feed on meat's chemical parameters of the experimental group was relatively better. Fat content and other chemical composition of meat are affected by many factors, but the most important are the type of fish, nutrition (composition of feed), bioactive compounds, genetics, sex, age, type of fish body tissue (Fauconneau et al., 1995; Mráz, 2012).

Conclusions

So in conclusions, it could be said that extruded compound feed supplemented with hydrolyzed protein from feathers and pig bristle had positively effect on meat chemical and technological parameters, but extruded compound feed supplemented with hydrolyzed protein from just feathers had positively effect on African catfish productivity.

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