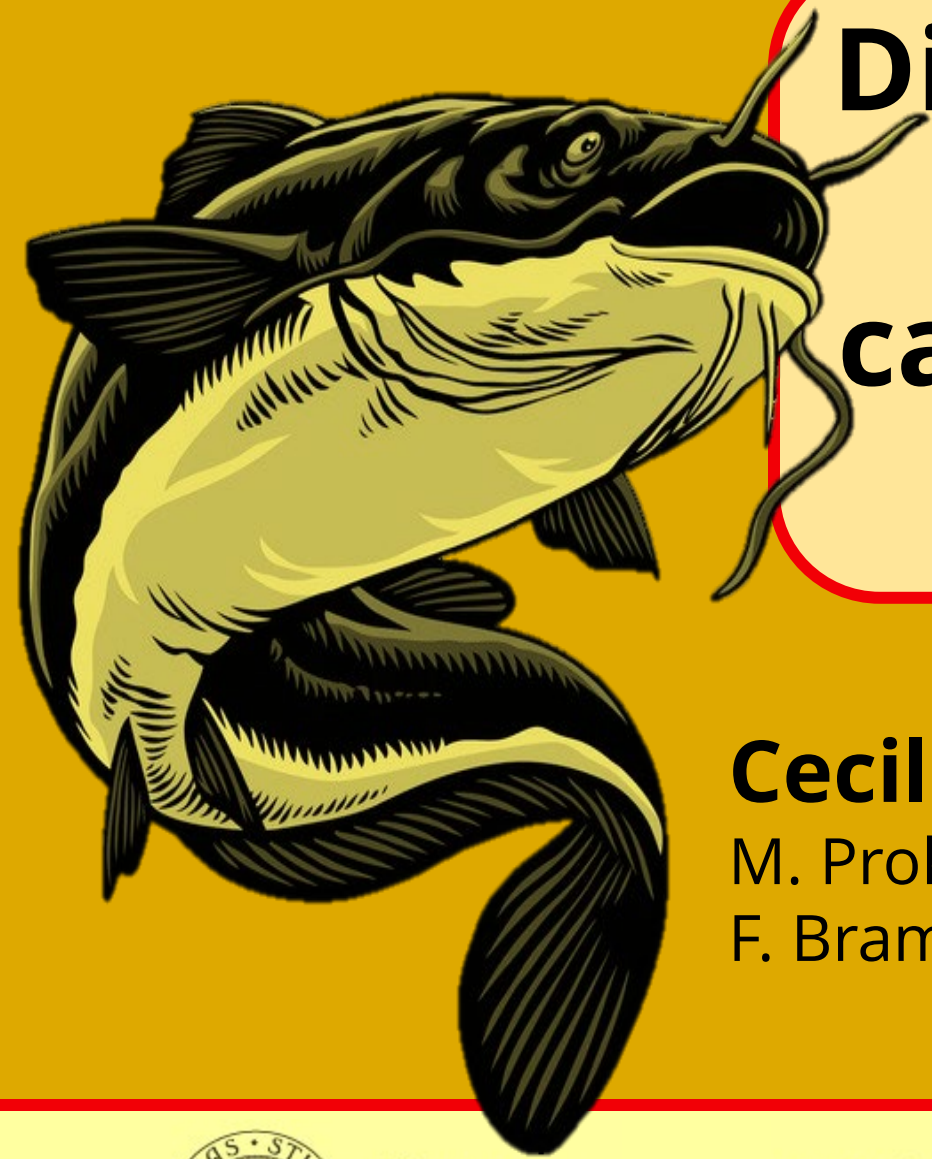




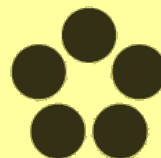
Diet digestibility and growth performance of African catfish fed diets with blends of poultry PAP

Cecilia Fanizza, A. Trocino, V. Stejskal, M. Prokèšová, M. Zare, H. Quang Tran, F. Brambilla, G. Xiccato, F. Bordignon



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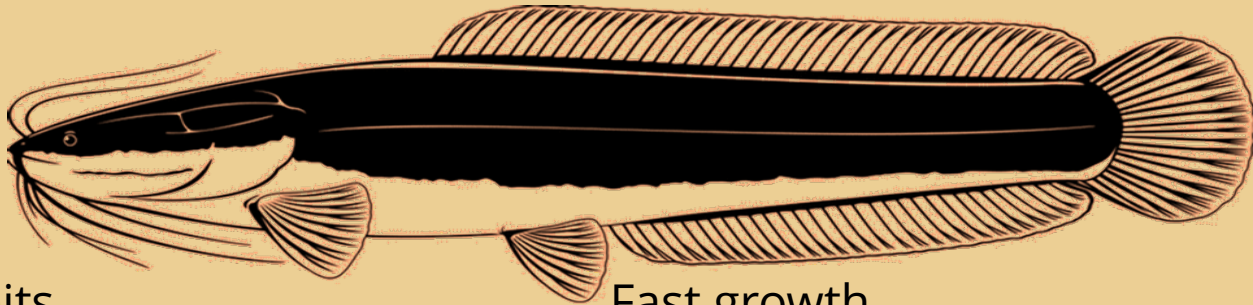
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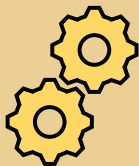
Jihočeská univerzita
v Českých Budějovicích
University of South Bohemia
in České Budějovice

natur**Alleva**
FEEDS FOR AQUACULTURE

Background



6.8 million tons in 2020
Land-based systems



Cultural habits
Taste perceptions
Poor marketing
Farming practice concerns
Competition with alternatives



Fast growth
Efficient feed conversion ratio
Adaptable to different conditions
High stocking densities
Fillets with high nutritive value

Processed Animal Proteins (PAPs)

Poultry By-product Meal

75-90% of protein
+8% production (2024 to 2029)
350 EUR per tons in 2023



Hydrolysed Feather Meal

80-85% of protein
+9% production (2024 to 2029)
165 EUR per tons in 2023



Dry-blood Meal

90-95% of protein
+3% production (2024 to 2029)
265 EUR per tons in 2023



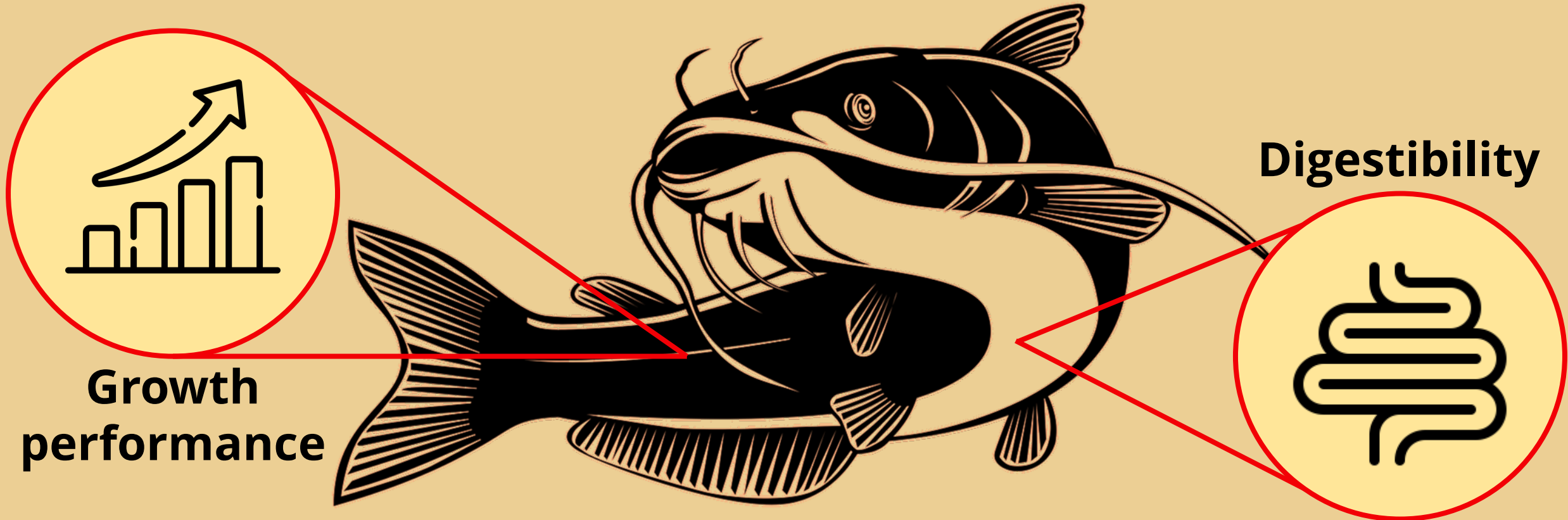
**MINIMISE THE
AMOUNT OF
FISHMEAL**

**PRESERVE
PRODUCTION
EFFICIENCY**

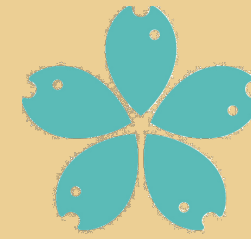
**INCREASE ECONOMIC
AND ENVIRONMENTAL
SUSTAINABILITY**

Aim of the study

Effects of 4 **commercially available, market-consistent**, and **price-stable** practical diets formulated with decreasing levels of fishmeal (9 to 1 %) and increasing levels of blends of poultry PAPs (23 to 39 %) for African catfish (*Clarias gariepinus*) reared in controlled RAS conditions



Fish rearing conditions



Fakulta rybářství
a ochrany vod
Faculty of Fisheries
and Protection
of Waters



600 catfish

(116 ± 16 g)

in 12 RAS tanks

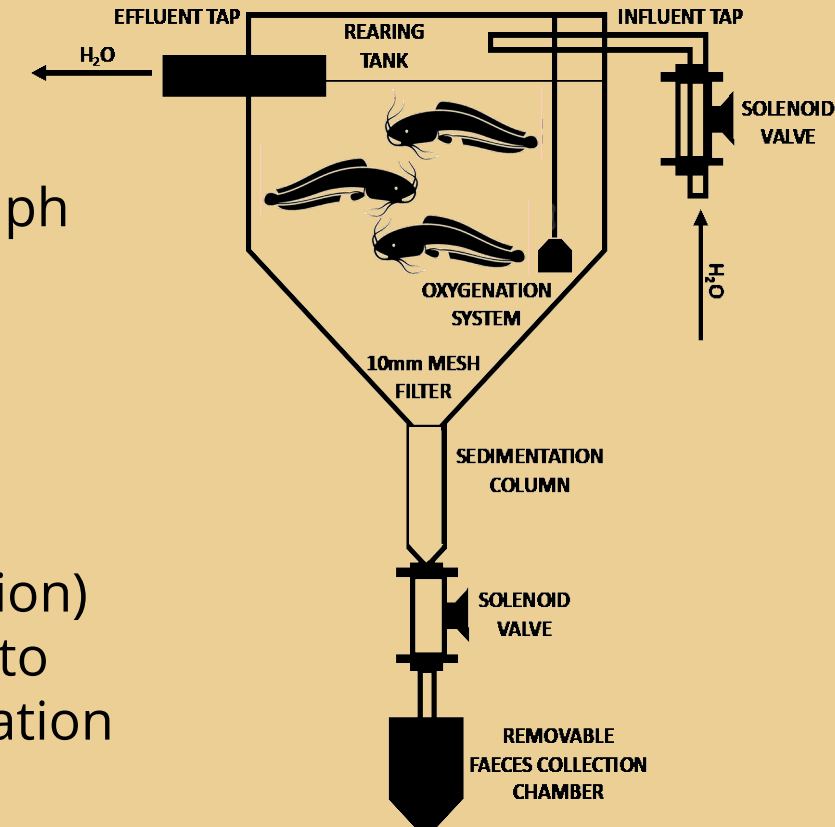
(50 fish per tank)

equipped with Guelph
system

84-day trial

(+1 week of adaptation)

3 tanks per diet fed to
visual apparent satiation



Water parameters and mortality were checked daily

Experimental diets



Commercial diets were formulated according to the specifications and requirements of the aquafeed company **NaturAlleva** (VRM s.r.l., Verona, Italy), ensuring industry standards for **nutritional balance**, **ingredient quality**, and **regulatory compliance**

	9FM-23PAP	5FM-28PAP	9FM-31PAP	1FM-39PAP
Fishmeal from by-products (CP 66% DM)	9.1	4.6	9.2	1.0
Poultry by-product meal (CP 64% DM)	4.5	9.9	14.2	16.5
Hydrolysed feather meal (CP 85% DM)	9.0	9.0	12.7	13.6
Poultry dry-blood meal (CP 90% DM)	9.1	9.1	4.6	9.1
Total PAPs	22.7	28.0	31.4	39.2
Soybean meal	14.5	11.6	7.4	0
Rapeseed meal	13.6	13.6	13.7	18.1
Wheat meal	16.3	18.1	19.1	22.7
Corn gluten meal	4.2	4.4	0	0
Pea meal	9.0	9.0	9.1	8.5
Total vegetable protein meals	57.5	56.6	49.2	49.3
Other ingredients*	10.8	10.8	10.2	10.5

*Other ingredients: whey protein concentrate; hydrolysed fish protein; rapeseed vegetable oil; fish oil; DL-methionine; emulsifier (E484); vitamin and mineral premix; vitamin C

ISONITROGENOUS (CP: 44 % DM) **ISOLIPIDIC** (EE: 12 % DM) **ISOENERGETIC** (gross energy: 16.5 MJ kg⁻¹)

Digestibility and growth indicators

Digestibility

Faecal samples collected 2 times x day
12 pools chemically analysed
(3 tanks x 4 diets)

ADC of protein and lipids Cho et al., 1982

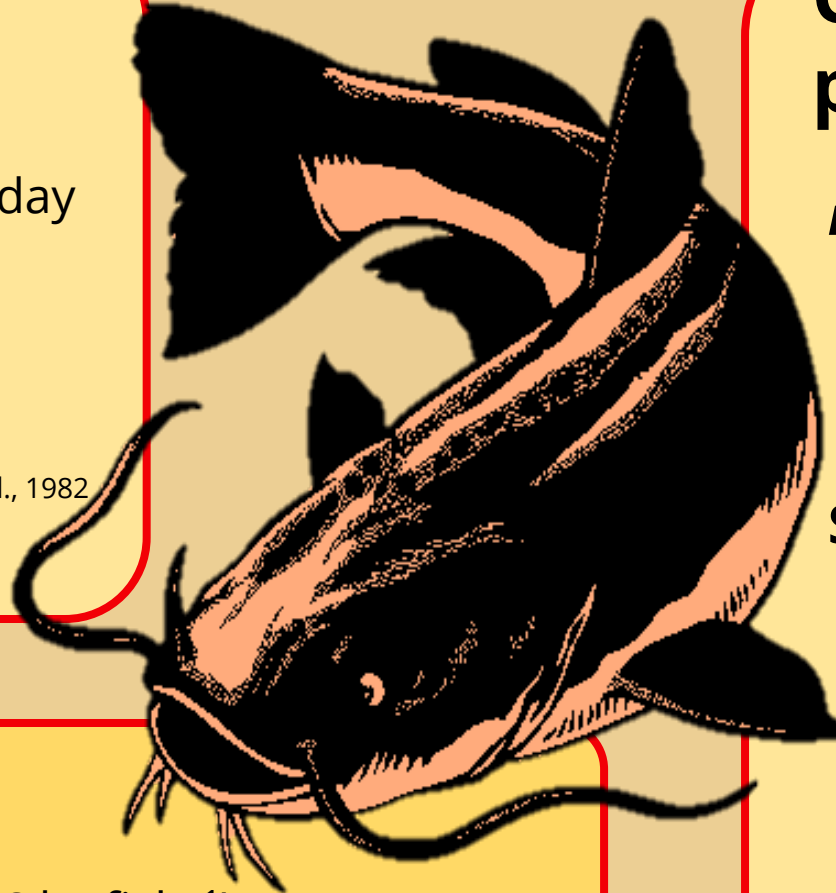
Fibre as indicator Krontveit et al., 2014

Economic analysis

Feed Cost to produce 1 kg of fish (€ kg fish^{-1}) Fanizza et al., 2023

Economic Conversion Ratio (ECR, € kg fish^{-1}) Martínez-Llorens et al., 2007

Economic Profit Index (EPI, € fish^{-1}) Martínez-Llorens et al., 2007



Growth performance

in vivo recordings

Survival (%)

Fulton's condition factor (Kc)

Specific Growth Rate (SGR, $\% \text{ day}^{-1}$)

Feed Conversion Ratio (FCR)

Slaughtering recordings

Intraperitoneal fat index (%)

Gonadosomatic index (%)

Hepatosomatic index (%)

Spleen somatic index (%)

Viscerosomatic index (%)

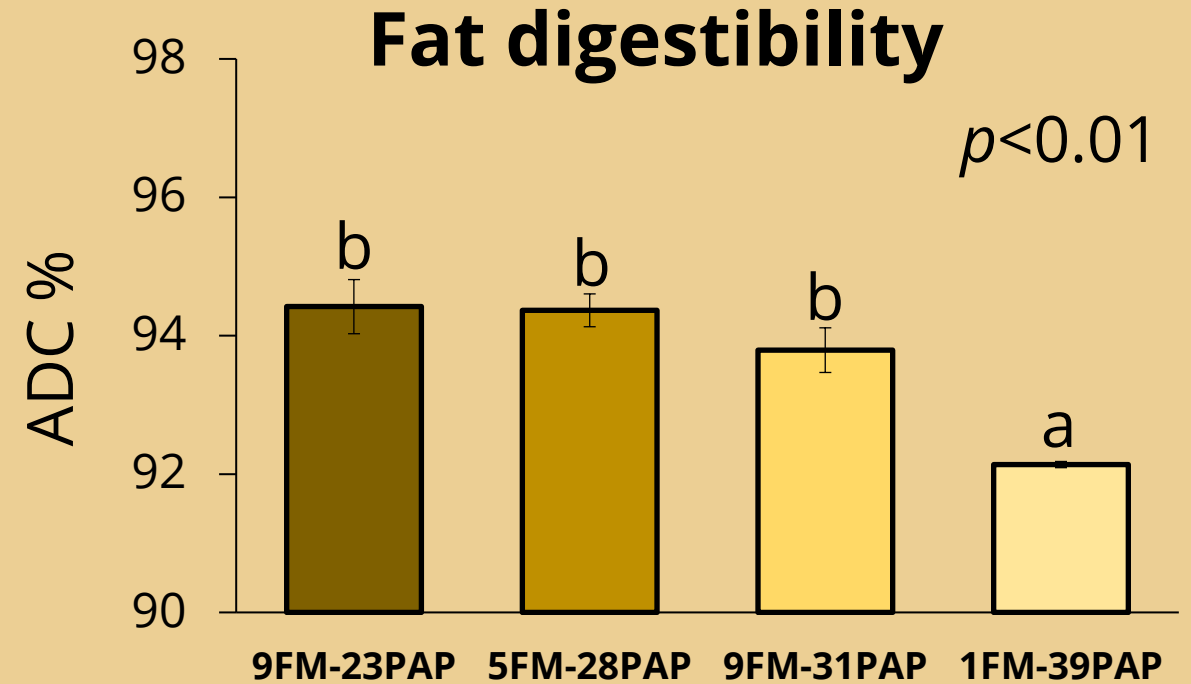
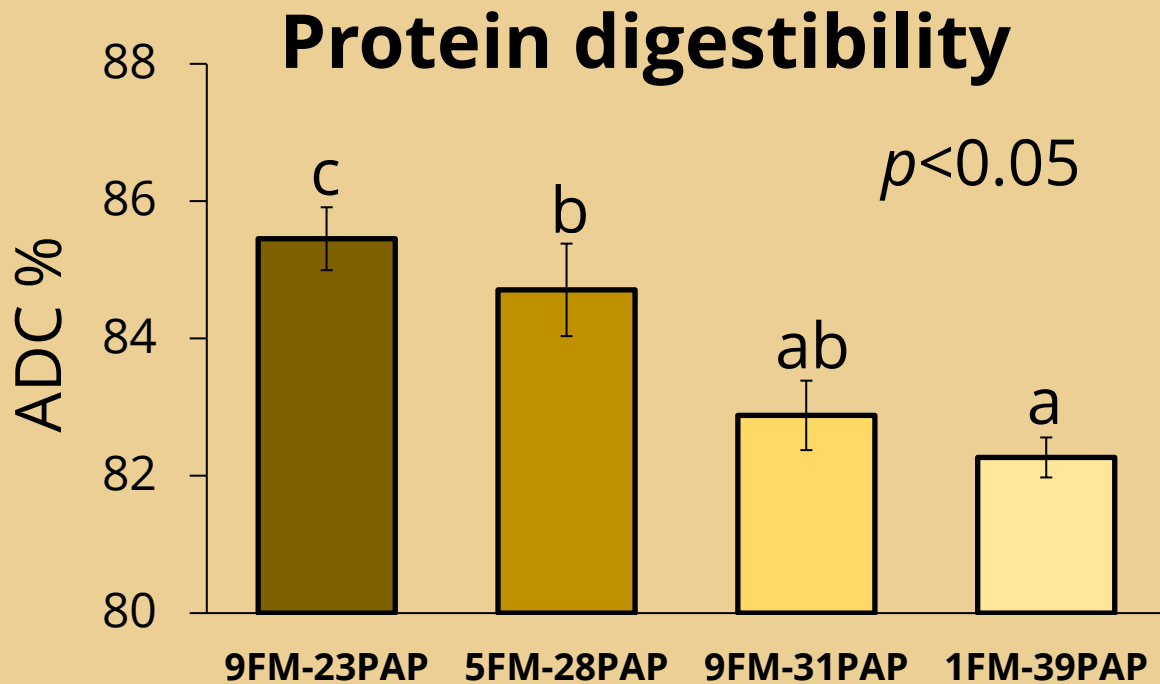
Carcass yield (%)

Head incidence (%)

Fillet with skin yield (%)

Fillet without skin yield (%)

Digestibility



Diet 1FM-39PAP resulted in the lowest protein and fat digestibility

fluctuations in inherent
content of feathers,
connective tissue, and skin

processing method and
long exposure to high
temperatures

high content of
rapeseed meal

Growth performance

	9FM-23PAP	5FM-28PAP	9FM-31PAP	1FM-39PAP	p-value
<i>in vivo</i> recordings					
Survival, %	94.5 ^a	96.8 ^b	94.3 ^a	94.6 ^a	<0.001
Fulton's condition factor	0.87 ^b	0.86 ^b	0.84 ^{ab}	0.83 ^a	<0.001
Specific growth rate, % d ⁻¹	3.23 ^c	3.18 ^{bc}	3.00 ^b	2.69 ^a	<0.001
Feed conversion ratio	1.14 ^a	1.06 ^a	1.14 ^a	1.34 ^b	<0.001
slaughtering recordings					
Somatic indexes, %	n.s.				
Carcass yield, %	91.4	90.3	90.8	90.7	n.s.
Head incidence, %	26.3	27.2	26.8	27.7	n.s.
Fillet yield (with skin), %	47.8 ^b	46.3 ^{ab}	46.9 ^{ab}	45.5 ^a	0.03
Fillet yield (without skin), %	39.8	38.8	39.4	38.0	n.s.

Diet 1FM-39PAP did not adequately support productive performance

low palatability of diets with
high inclusion of poultry and
feather meals

low inclusion of
fishmeal

feather meal lacks essential
amino acids due to poor keratin
hydrolysis process

Economic analysis

	9FM-23PAP	5FM-28PAP	9FM-31PAP	1FM-39PAP
Feed production cost EUR kg ⁻¹	0.66	0.64 -3% vs. 9FM-23PAP	0.65 -2% vs. 9FM-23PAP	0.58 -12% vs. 9FM-23PAP
Feed cost to produce 1 kg of fish EUR kg ⁻¹	0.75	0.68 -9% vs. 9FM-23PAP	0.57 -24% vs. 9FM-23PAP	0.78 +4% vs. 9FM-23PAP
Economic Conversion Ratio-ECR EUR kg fish ⁻¹	1.28	1.18 -8% vs. 9FM-23PAP	1.46 +14% vs. 9FM-23PAP	1.78 +39% vs. 9FM-23PAP
Economic Profit Index-EPI EUR fish ⁻¹	1.45	1.29 -11% vs. 9FM-23PAP	1.27 -12% vs. 9FM-23PAP	1.18 -19% vs. 9FM-23PAP

Strategic Ingredients Assessment



REPLACE FISHMEAL WITH POULTRY PAPS



Fishmeal of min. 5%
Poultry meal up to 10%
Feather meal up to 9%



Improvement of feed economic competitiveness
Favourable growth performance and diet digestibility



REPLACE BLOOD MEAL WITH POULTRY AND FEATHER MEALS



Blood meal from 9 to 5%
Poultry meal $\geq 14\%$
Feather meal $\geq 13\%$



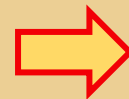
Lower cost for feed production
Worse ECR and EPI
Impairments of growth performance and digestibility



REPLACE FISHMEAL WITH BLOOD MEAL



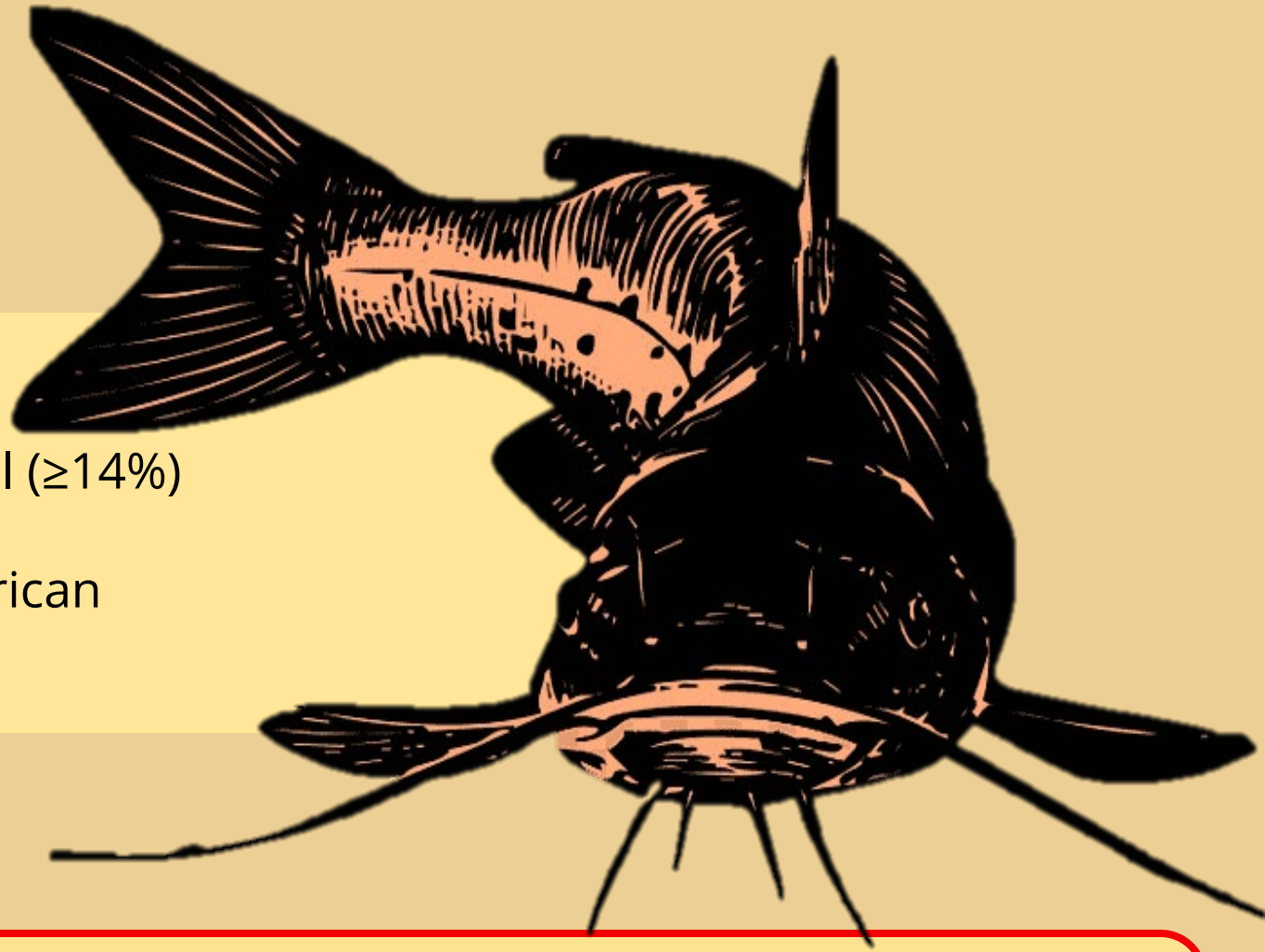
Fishmeal from 9 to 5%
Blood meal of 9%
Poultry and feather meals not above 10%



Enhance of feed economic competitiveness
Favourable growth and digestibility performance

Conclusions

Low dietary inclusion of fishmeal (1%) and a high inclusion of poultry by-product meal ($\geq 14\%$) and hydrolysed feather meal ($\geq 13\%$) did not support adequately performance of African catfish reared in a RAS system



A diet with a medium inclusion of fishmeal (5%) and medium inclusion of a blend of PAPs (28%) resulted technically and economically profitable, assuring high fish survival rate and good growth performance

Thanks for your attention

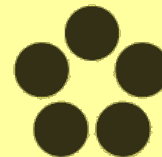


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FEEDS FOR AQUACULTURE

Statistical analysis

All data were checked for normality through a Shapiro-Wilk test

- Data of catfish biometry were submitted to ANOVA (PROC MIXED, SAS 2013)
- Fish survival was analysed using PROC CATMOD, SAS 2013
- Diet digestibility, SGR and FCR and slaughter results were submitted to ANOVA (PROC GLM, SAS 2013)

The Bonferroni test was used to compare least square means

Differences among least square means with $p < 0.05$ were assumed to be statistically significant

