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Faculty of Fisheries and Protection of Waters

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University of South Bohemia in České Budějovice

CENAKVA
South Bohemian Research Center of Aquaculture and Biodiversity of Hydrocenoses

Nutritional requirements and its effects on growth performance of percid fish in European freshwater intensive aquaculture

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💪 About me …

- PhD. Study – specilization: Fisheries (2021-present)
- member of EAS (since 2022)
- Focus:
  - (i) optimizing the feeding management in intensive pikeperch culture
  - (ii) determination of pikeperch feeding requirements and its influence on survival and growth
  - (iii) investigation of the effects of bicultural stock on feed utilization in RAS

Content:

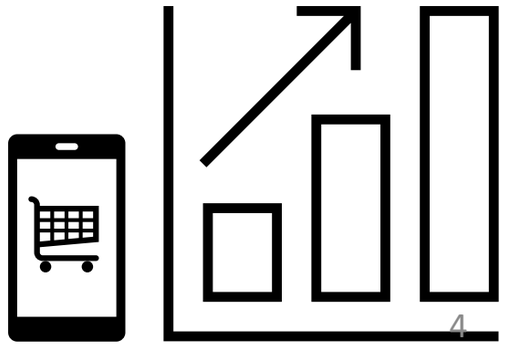
- Introduction
  - The importance of percid fish in European aquaculture
  - Biological and economic benefits
  - Intensive aquaculture systems
  - Economic challenges and opportunities
  - Nutrition of pikeperch in aquaculture
  - Rearing parameters for effective feeding
- Meta-analysis for European percid aquaculture
- Challenges for the future
  - Economic and environmental sustainability of feed in intensive aquaculture
  - Legislative constraints and their impact on the use of new feed types
  - Perspectives and future research on the nutritional needs of percid fish

The importance of percid fish in European aquaculture

- **Economic value** 📈:
  ↑ demand for freshwater species in Europe
  ↑ price on markets due to quality of meat and ease of cooking

- **Ecological importance** ♻️💚:
  Species native to European freshwater ecosystems
  Adaptability to intensive aquaculture (RAS)

- **Diverse market** 🧑‍🔬📊:
  ↑ demand for perch and pikeperch not only in Europe but also on international market
  ↑ popularity in gastronomy, especially in haute cuisine and restaurants

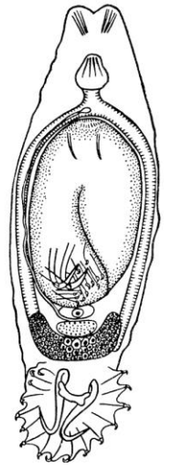


Biological and economic benefits

- **Growth capabilities** :
  - ↑ growth efficiency, proper nutritions
  - Pikeperch: rapid growth, ↑↑ feed conversion
  - Perch: slower growth, ↑ quality meat

- **Disease resistance** :
  - Both species relative resistance to common diseases in aquaculture environment
  - Properly fed and maintained in a clean and stable environment

Gyrodactylus longiradix

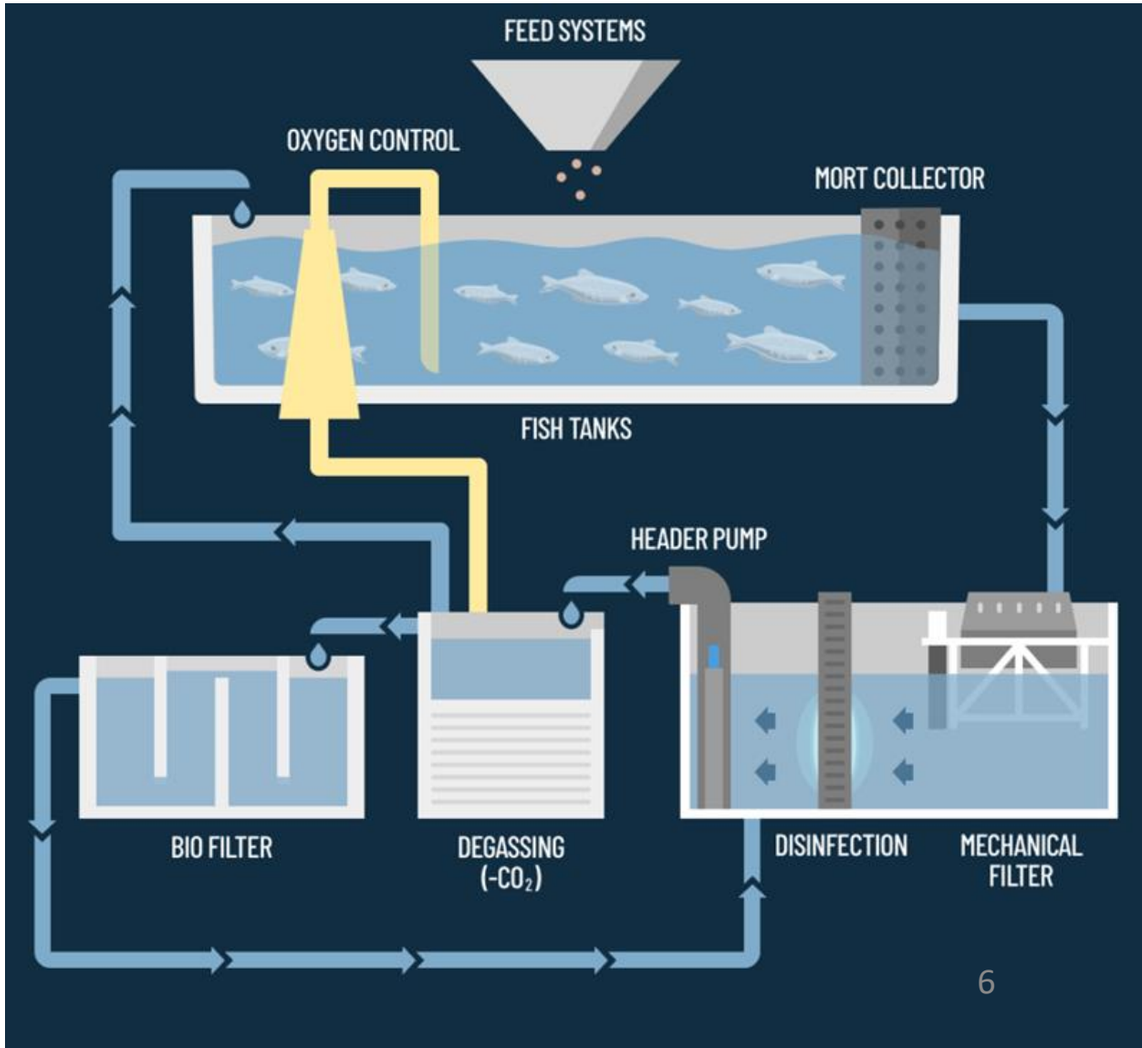


Intensive aquaculture systems

- **<u>Recirculation systems (RAS)</u>** 💡:
  - Ideal for growing percid fish
  - Control temperature, water quality and stocking density
  - Improvement of growth and overall production, reducing the ecological footprint

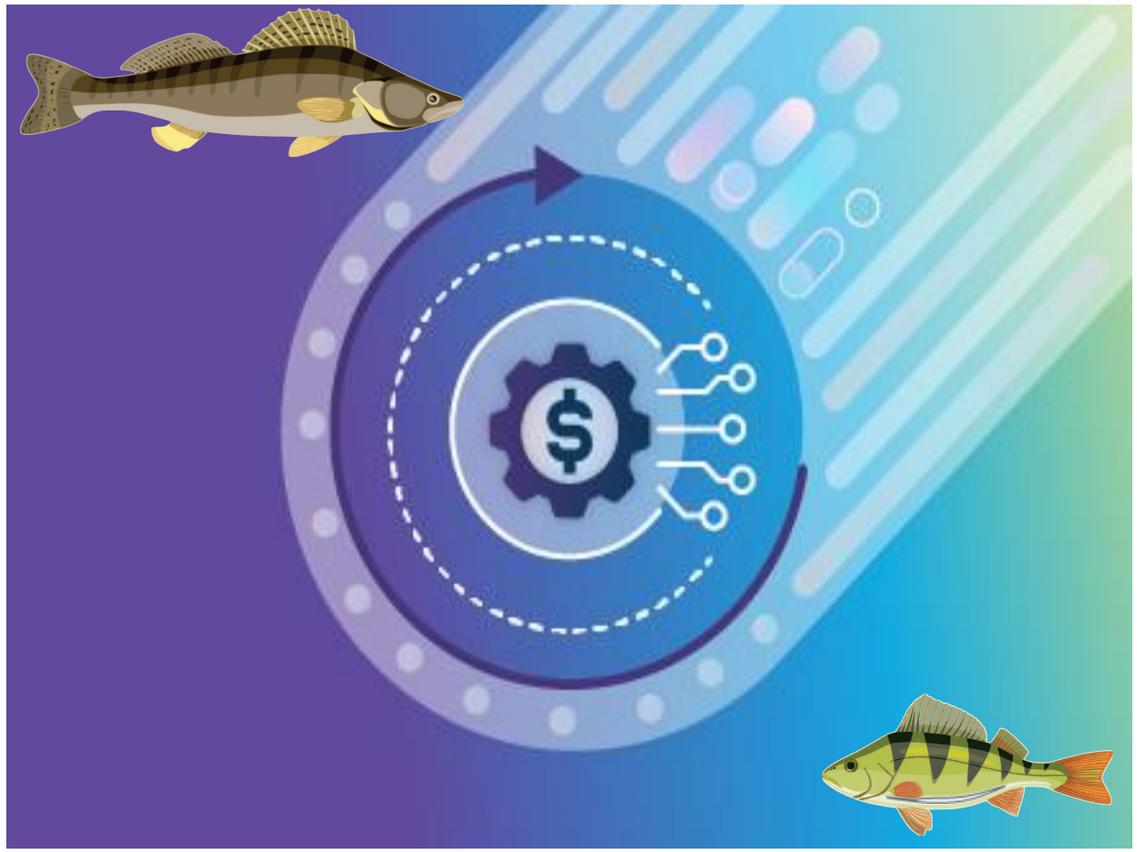
- **<u>Sustainable production</u>** ♻🔋 :

  Percid fish can be produced with ↓↓ environmental impact



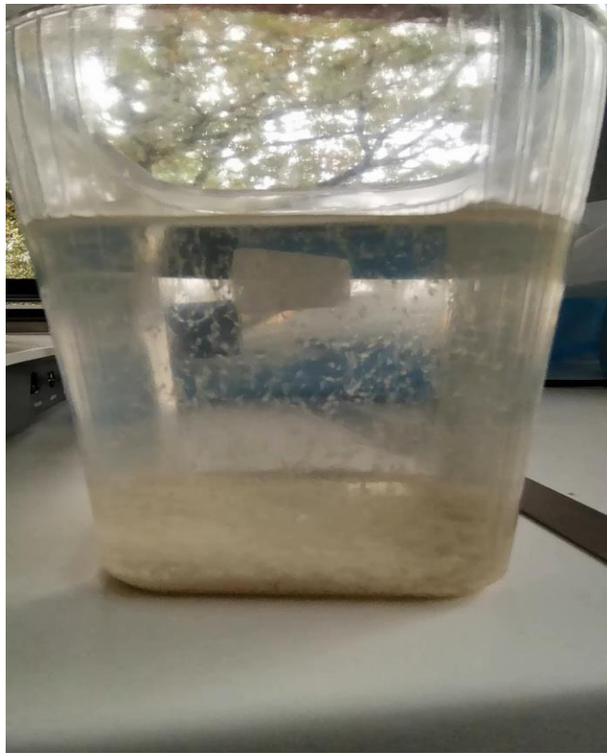
Economic challenges and opportunities

- **Feed costs** 📋💲:
  - The nutritional needs high quality and specially formulated feed
- **Investment in technology** 🛠️💲:
  - ↑↑ initial investment in technology solutions
  - (RAS), higher productivity and lower long-term costs
- **Market potential** 📈🤑:
  - The market for percid fish ↑↑
  - Restaurants and specialty food sector



Nutrition of pikeperch in aquaculture

- Challenges associated with the nutrition of pikeperch
- Specific requirements of the nocturnal predator
- Demanding larval diet
  - Small body size at the start of feeding
  - Susceptibility to cannibalism at an early stage



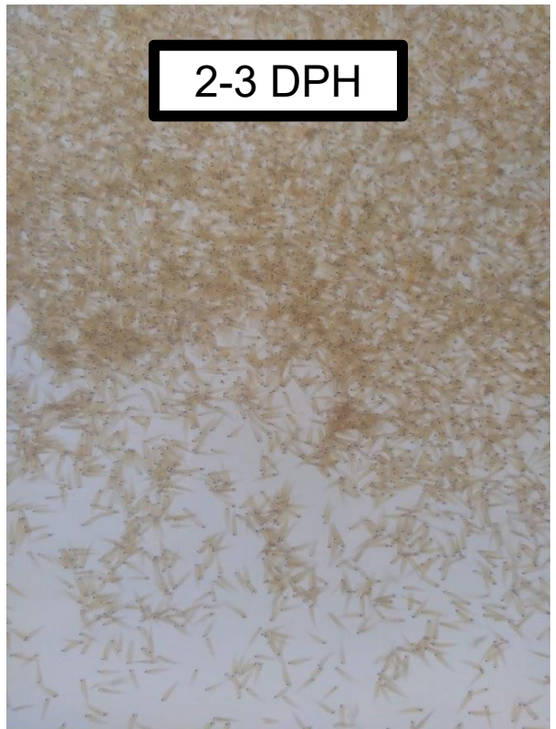
Nutrition of pikeperch in aquaculture (larvae)

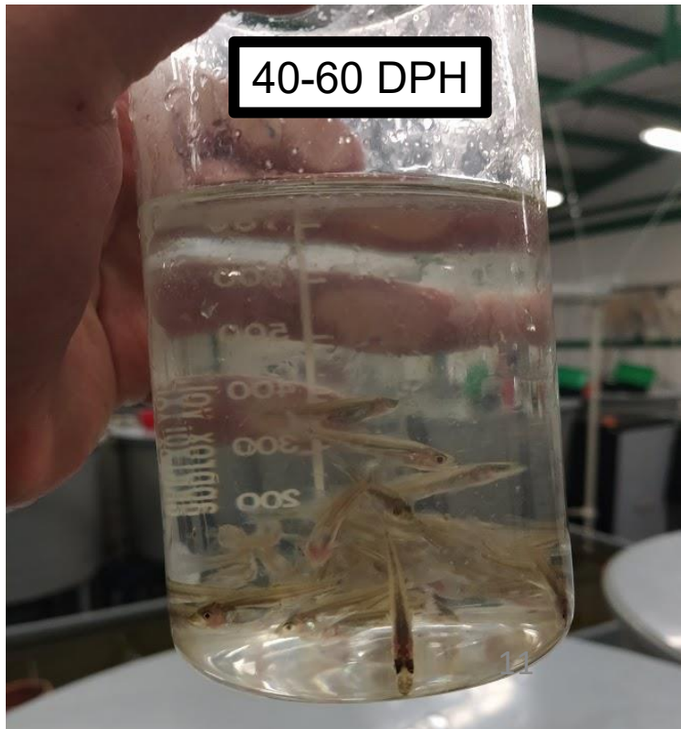
- Small size of larvae after hatching
- Short feeding time from yolk sac
- Feeding required within 10 days at 15-17 °C
- Key factors for successful feeding:
  - **Type of feed**

Diets of larvea	Days of the experiment	Initial body weight (mg)	Final body weight (mg)	Survival rate (%)	Literature source
Zooplankton from the lake	19-28	0.3-0.5	70-80	27-44	Schlump-berger and Schmidt, 1979
Artemia (non-enriched)	14	3.4	105.8	64.5	Mamcarz et al., 1997
	35	0.8	212	54.4	Ostas-zewska et al., 2005
	24	3.1	363	24.8	Kestemont et al., 2007
	18	8.1	301	71.4	
Artemia (enriched with highly unsaturated fatty acids and vitamin C)	18	8.1	373	70.9	
Artemia and Zooplankton	35	0.5	120-150	26.7	Klein Breteler, 1989
Artemia and rotifers	12	0.66	-	53-68	Imentai et al., 2020
Rotifers	12	0.55	28	74	Yanes-Roca et al., 2018
Artemia and rotifers	12	0.55	5.66	64	
Artemia and rotifers (enrinched)	18	-	-	76	Yanes-Roca et al., 2020
Marine larval feed	35	0.8	190	52.4	Ostas-zewska et al., 2005
Casein-based diet	35	0.8	53.8	28.4	
Freshwater larval diet	18	8.1	231	77.4	Kestemont et al., 2007
Marine larval feed	18	8.1	144	63.9	
Diet with soy phospholipids	25	2.5	160-238	33-36.2	

Nutrition of pikeperch in aquaculture (larvae)

- Key factors for successful feeding:
  - **Size and nutrient composition**





Nutrition of pikeperch in aquaculture (larvae)

- Key factors for successful feeding:
  - **Size and nutrient composition**

Days post hatching (DPH)	**5 DPH**	**8-15 DPH**	**DPH 15-19**
Feed	Feed enriched with rotifers (*Chlorella vulgaris*)	Artemia	Micro-particulate dry food (**slow change over 9 days**)

Nutrition of pikeperch in aquaculture (larvae)

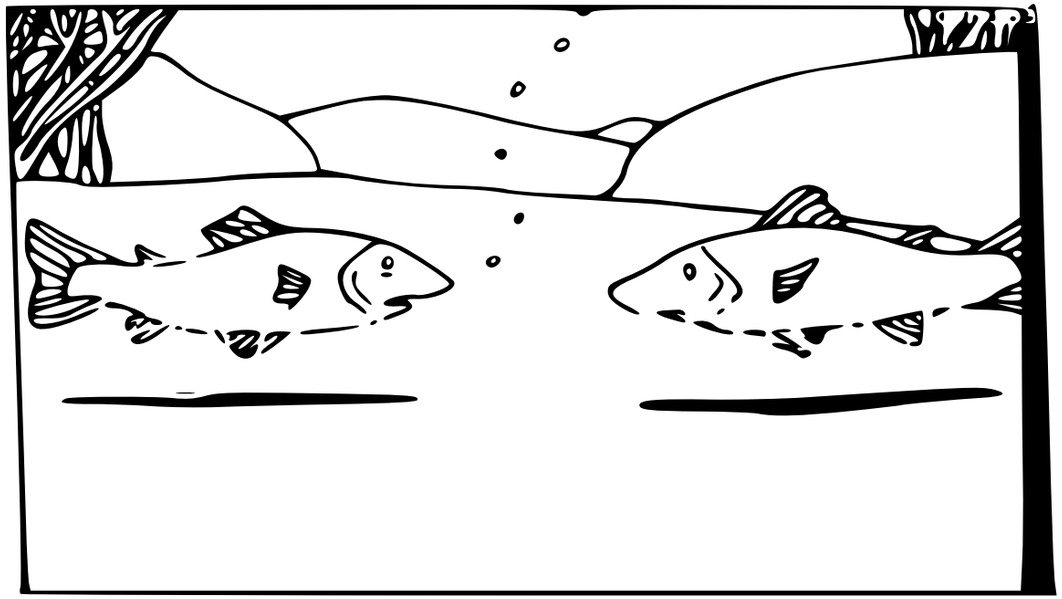
- Size and nutrient composition
  - **The importance of proteins and fats**
  - **Importance of AA and FA composition**
- Role of fatty acids
  - **SFA and USFA as a source of energy**
  - **Polyenoic fatty acids for building body components (muscle, brain, retina)**
  - **Importance for development and stress resistance**

Nutrition of pikeperch in aquaculture

- **Composition and quantity of feed 🍱:**
  - Depends on the size of the fish
  - Protein requirement decreases as fish age
- **Proteins 🍳🥩🍖:**
  - Breaks down into AA and peptides
  - Fry: 47-54% crude protein
  - Juvenile (≥51.1g): 43-50 % crude protein
  - Commercial feeds: 54-62 % crude protein

Nutrition of pikeperch in aquaculture

- **Fats** 🧈🥑 **:**
  - Energy source, protein-sparing effect
  - Optimal ratio of crude protein to fat
  - Fry: **17 % fat**
  - Juveniles (≥ 51.1 g): **10-16 % fat**
  - Adults (≥ 210 g): **10 % fat**

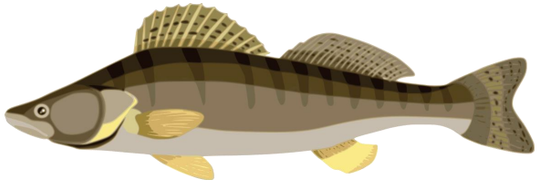


"With all these omega-3 fatty acids, you´d think I´d feel better."

Nutrition of pikeperch in aquaculture

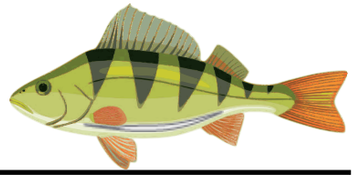
- **Carbohydrates 🍞🥐🥨:**
  - Carbohydrate to fat ratio affects growth
  - Optimal growth:
    43% protein
    22% fat
    20% carbohydrate

Nutrition of pikeperch in aquaculture



Life stages	Crude protein content (%)	Crude fat content (%)	Carbohydrate content (%)
Larvae, fry	47 – 54	17 – 18	N/A
Juvenile	43 – 50	10 – 16	15 – 20
Adult	N/A	N/A	N/A

Nutrition of perch in aquaculture



Life stages	Crude protein content (%)	Crude fat content (%)	Carbohydrate content (%)
Larvae, fry	43.6 – 56.5	N/A	N/A
Juvenile	46.6	12 – 19.3	N/A
Adult	N/A	N/A	N/A

Rearing parameters for effective feeding

- **Factors influencing feed conversion and growth:**
  - Abiotic factors: temperature, light intensity, wavelength of light, amount of feed
  - Biotic factors: interactions between abiotic factors
- **Temperature and growth 🌡:**
  - Optimal temperature depends on the size of the fish
  - Larger fish more sensitive to higher temperatures
  - Recommended temperatures:
    - **Larvae: 26-30 °C**
    - **Juvenile (≥84 g): 25 °C**
    - **Adult: 18.8 °C**

Rearing parameters for effective feeding

- **Lighting conditions 🔦⚡:**
  - prefers turbid waters, crepuscular
  - *Tapetum lucidum* for better vision in low light conditions
  - High light intensity =⟩ stress and reduces feed turnover
  - Sensitivity to light increases with fish size
  - Adult pikeperch prefer low light intensity

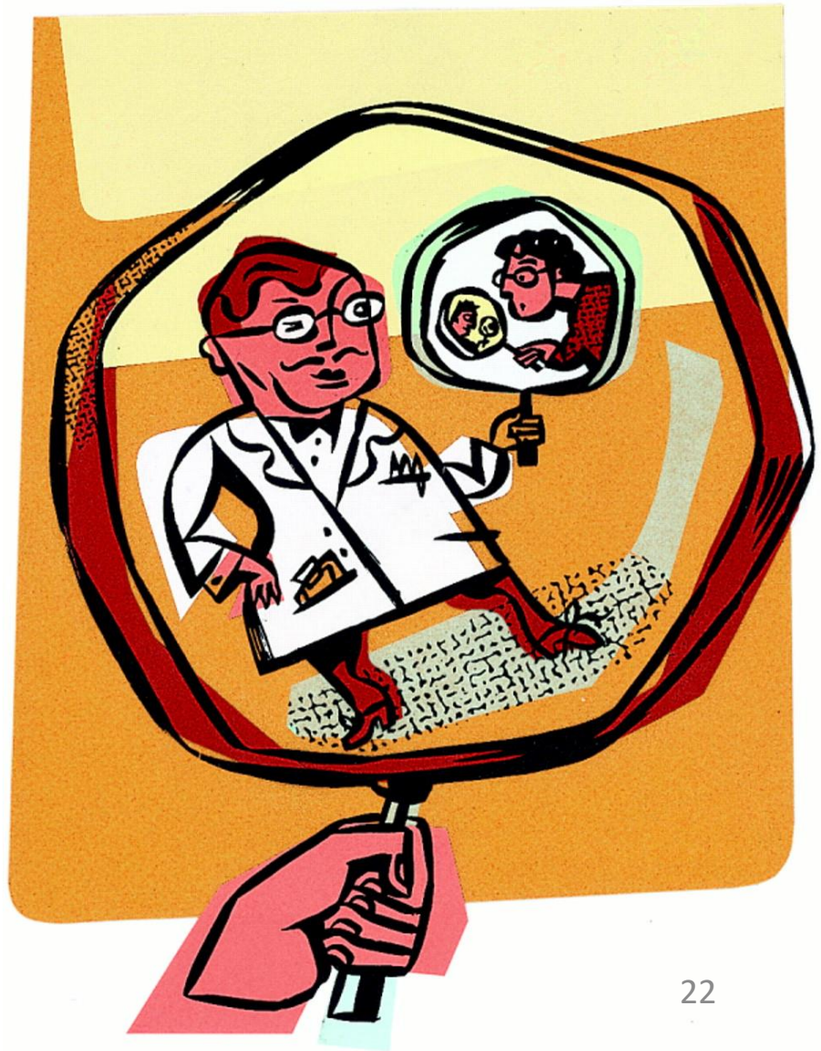
Rearing parameters for effective feeding

Life stages	Water temperature (°C)	Light intesity (lux)	Wavelength of light (nm)	Amount of feed (% of body weight)
Larvae, fry	26 – 30	10 – 45	610	1.5 – 6
Juvenile (≥84 g)	25	1 – 1.2	610	2
Adult	18.8	<1	610	1.1 – 1.25

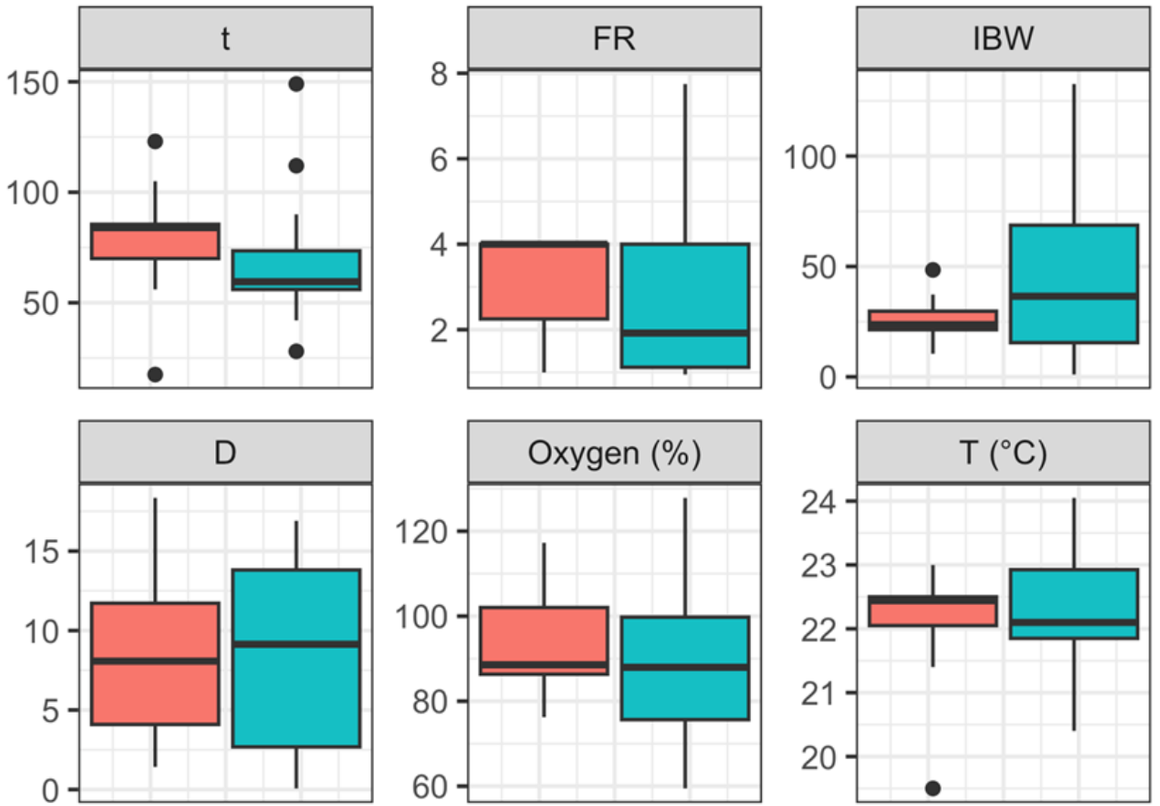
Meta-analysis for European percid aquaculture

- Meta-analysis of 23 peer-reviewed articles (1996-2023)
  - Significant effect of crude protein (CP), crude lipid (CL) and crude energy (CE) content on the growth of percids
- Optimal conditions for growth

  Highest thermal growth coefficient (TGC) at:
  - CP ~54.5%
  - CE ~4080 kcal kg^{-1}
  - CL level of 15.0-15.5% maximizes TGC and specific growth rate (SGR)
- Further findings
  - Unclear maximum for CE and non-nitrogen free extracts (NFE) content for SGR
  - Minimum SGR around 19% for NFE
  - Two local maxima for SGR at a coarse ash (CA) content of 9-12%



Meta-analysis for European percid aquaculture



Essential amino acid (EAA)	Requirement (mg g^{-1} protein)
Arginine	67.86
Histidine	41.51
Lysine	**93.55**
Isoleucine	55.14
Leucine	79.22
Methionine	**39.40**
Phenylalanine	51.22
Threonine	51.80
Tryptophane	9.22
Valine	62.72

Meta-analysis for European percid aquaculture

- Ideal protein concept for optimal feeding conditions 💭🍱 :
  - Quality protein sources: fish, crustaceans, poultry, insects, potatoes, rice [digestible indispensable amino acids score (DIAAS): **>60%**]
  - Suboptimal protein sources: blood, keratin/feathers, gelatine, insects, nuts, corn, guar, canola, bacteria (DIAAS: **<15%**)

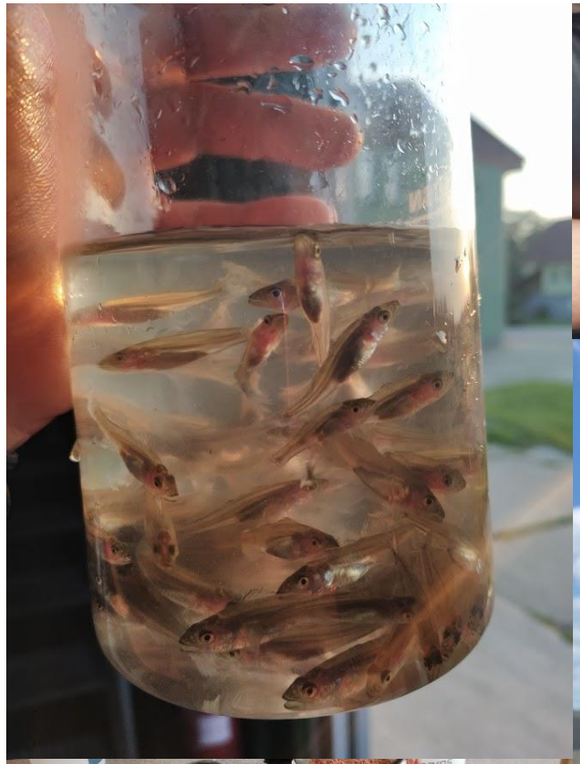
- Energy sources ⚡:
  - Lack of information on carbohydrate processing by percids
  - High lipid content is favourable

Challenges for the future

1. Economic and environmental sustainability of feed in intensive aquaculture ♻️🌾🏞️

2. Legislative constraints and their impact on the use of new feed types ⚖️🍔🐟

3. Perspectives and future research on the nutritional needs of percid fish 🔮🔬🌈



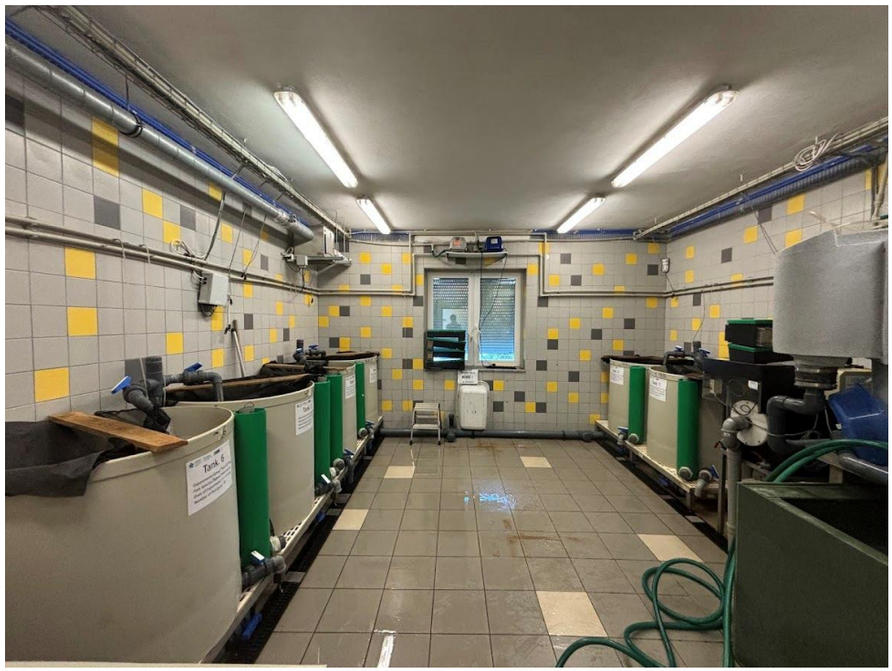
Challenges for the future ♻️🌾🏞️

- **Key question 🔑 :**
  - Interest from fishermen, legislative bodies and scientific institutions
  - Balance between efficient fish growth and ↓↓ environmental impacts
- **Main objective 🎯:**
  - Feed innovation, new technologies and supporting legislative framework
- **Alternative raw materials for feed 💭🥩:**
  - Traditional feeds: fishmeal and fish oil
  - Alternative protein sources: **insect, algae, soy**
  - Reduction of ecological burden
  - Economic benefits (**lower costs $$, sustainability**)
- **Challenges 🚣:**
  - Meeting the nutritional requirements of percids
  - Specific requirements for AA and FA

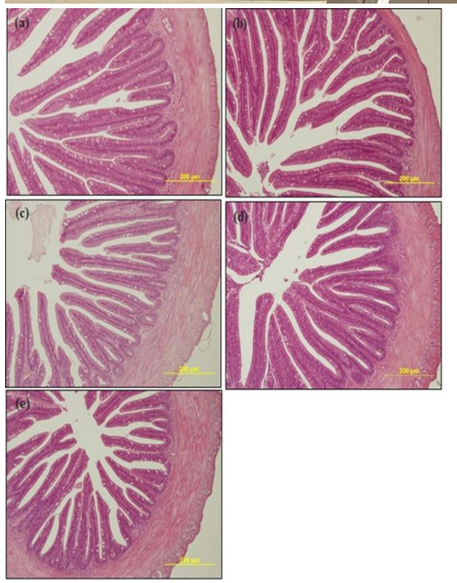
Challenges for the future ⚖️🍔🐟

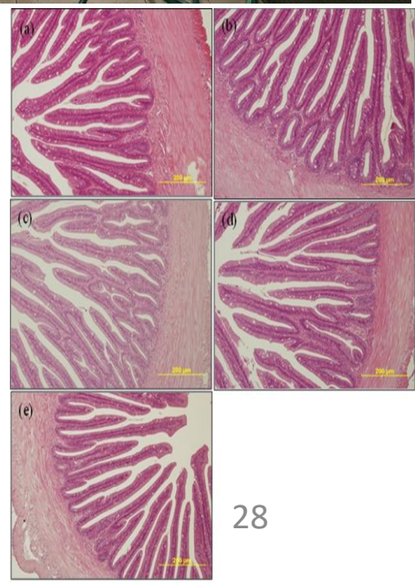
- **Legislative restrictions and regulation ⛔🚧😳:**
  - Significant impact on the use of new types of feed
  - Strict rules in the EU and other regions
- **Reasons for legislation 📝🏛️:**
  - Food safety
  - Quality of fish products
  - Impact on the environment
- **Approval process ✍️✅:**
  - Slowing down the introduction of new technologies and products
  - Ensuring safety and sustainability of feed
- **Other legislative factors 👷:**
  - ↑↑ transparency throughout the production chain
  - Possible changes in feed production and distribution practices

Challenges for the future 🔮🔬🎧



- **The future of research on the nutritional needs of percids** 🔜👩🥗:
  - Better understanding of nutritional requirements
  - Optimal growth
  - Minimal environmental impact
- **New technologies** 👩‍💻💪:
  - More accurate feeding in intensive systems (RAS)
  - Optimisation of nutrient supply
  - Minimisation of feed wastage
- **Research on the fish microbiome** 🔬🐟:
  - Relationship between gut microbiota and nutrient uptake efficiency

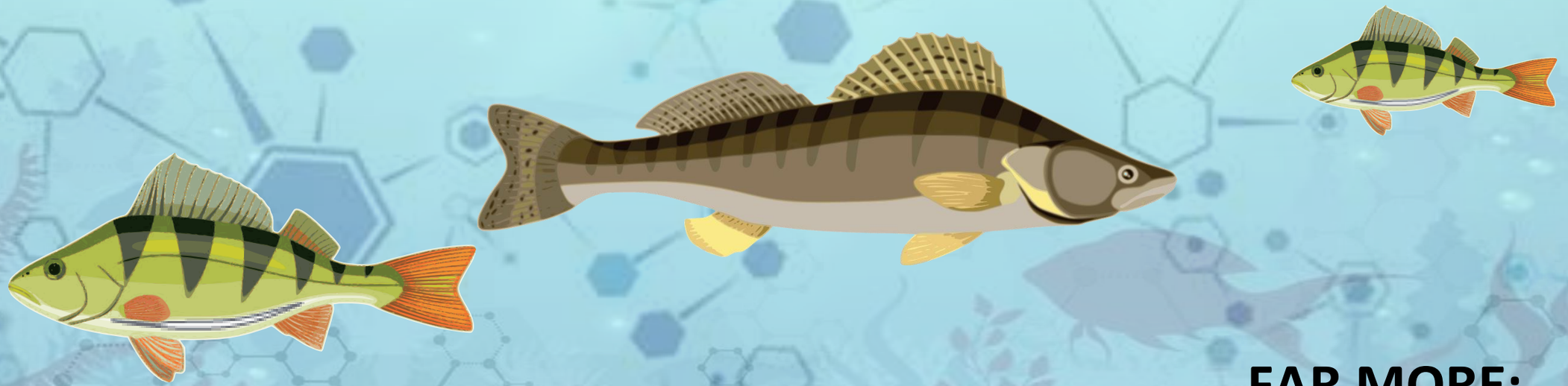




Challenges for the future 🔮🔬🐟

- $ **The economic side of sustainability** $
  - Investment in new technologies and feeds can be ↑
  - Long-term innovation leads to ↓ $$
  - ↓↓ ecological impact
- 🛠**Research and development**🛠
  - Continued research and development is key
  - New insights for process optimization
  - Ensuring sustainability of percid production
- **The future of feed in percid aquaculture**
  - Towards greater sustainability
  - Economic and environmental sustainability
  - Ensuring long-term sustainability and efficiency

THANK YOU FOR YOUR ATTENTION



ANY QUESTIONS?

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