

NUTRITION, FEEDS AND FEEDING

- **Digestive process in fishes**
- **Organs involved & function**
- **Nutritional requirements**
- **Feed processing/characteristics**
- **Energy budgets**
- **Feeding regimes/rates**

Carbohydrates

- **Carbohydrates (starches and sugars) are the most economical and inexpensive sources of energy for fish diets.**
- **Carbohydrates are included in aquaculture diets to reduce feed costs and for their binding activity during feed manufacturing.**
- **Carbohydrates are the major energy source for mammals but are not used efficiently by fish.**
- **Mammals can extract about 4 kcal of energy from 1 gram of carbohydrate, whereas fish can only extract about 1.6 kcal from the same amount of carbohydrate.**

CARBOHYDRATES

- Not very important for most fish species
- Appear as sugars and starches
- Carnivores have limited ability to digest sugars/starches
 - - May affect fish health
 - Catfish digest starch well –

CARBOHYDRATES

- Fish lack the enzyme cellulase
 - Unable to break down cellulose
 - Fiber usually considered to have 0 nutritional value.
- Cellulose often used as binding agent.
- Levels of 10 to 20% have resulted in growth depression in rainbow trout.

Classification of fish species based on water temperature

Coldwater: Carnivores

Coolwater: Carnivores or omnivores

Warmwater: Herbivores or omnivores

- **Feed must meet specific dietary requirements**

Energy Requirements of Aquatics

- The objective in formulating diets for most aquatic species is the same: finding a cheap energy source that is digestible and will spare protein
- Glucose is not acceptable in that it causes high blood sugar levels, poor growth, poor survival
- complex dietary COH's prove better.
- COH typically spares protein for growth.
- increase in dietary energy tends to increase performance when a diet low in protein is fed

Proximate analysis

Feed formulated based on analysis of individual ingredients

- Moisture
- Ether extract – fat soluble vitamins, carotene, chlorophyll, sterols, waxes, fats and fatty acids
- Ash
- Crude fiber – low digestible plant carbohydrates
- Nitrogen-free extract (NFE) – consists mainly of digestible carbohydrates

Other dietary factors

- **Attractants**

- **Attract fish by sight or smell (shrimp meal, fish oil, fish meal, etc.)**
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- **Pigments**

- **External**
 - **Crayfish, red snapper, koi, etc.**
- **Flesh color – pink in salmon or trout**
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 - **Must be obtained from feed (crustaceans, yeast, plants/algae)**

Other dietary factors

- **Behavior**
 - **How a feed particle moves through water column**
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- **Mimic natural food**

Feed Types

- **Dry feeds:**

- Made from all dry ingredients with addition of liquid fat (fish or oilseed oil)
- Pellets, crumbles, or flakes
- Floating or sinking feeds of various size designations

Practical diets

- **Pellets:**

- Feed ingredients mixed and forced under pressure through different size dies.
- Stability varies depending on binders used.

Practical diets

- **Microencapsulated – small particles of uniform nutritional make up:**
 - Slurry of fine ground ingredients
 - Encased in proteinaceous membrane (microcapsule)
 - Expensive, but used for some species (larval marine)
- **Moist and Semi-moist feeds (OMP – 32% moisture)**
 - Formulated with high % of whole fish
 - Stored frozen

Practical diets

- **Extruded feeds/pellets:**
 - Mixed ingredients passed through extruder barrel
 - Floating, slow sinking, and stable pellet
 - Increase lipid content (energy) by spraying extruded feeds after process
 - Enhanced digestibility of some ingredients