

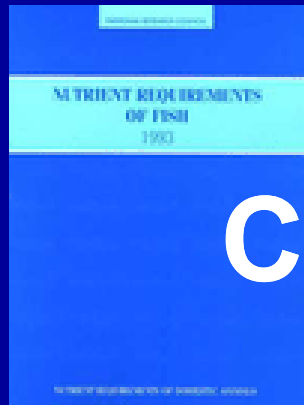
Diet Makeovers & Fish Performance: A Balancing Act



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Catfish Feeds & Feeding

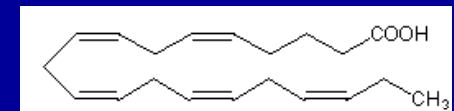
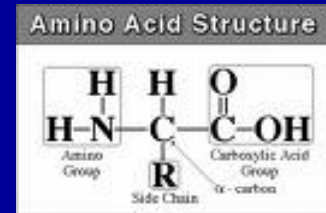


- **Intensive culture requires the use of feeds to achieve the desired level of production**
- **Feed costs are 50-60% of production costs**
- **Enormous potential to affect profit margin through diet and feeding strategies**

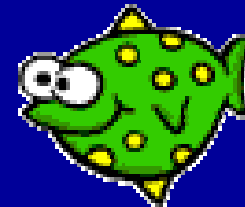
Why Feed Fish?

1) Essential nutrients:

- **Amino acids (from proteins)**
- **Fatty acids (from fats)**
- **Vitamins & minerals**

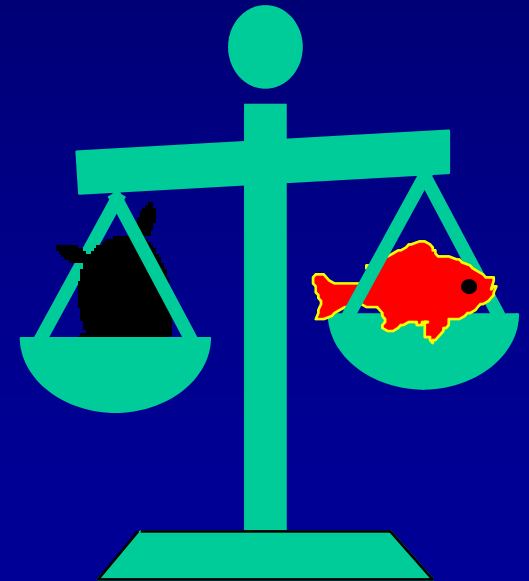


2) Energy: Protein, fats, carbohydrates



Advantages of Raising Fish vs Warmblooded Food Animals

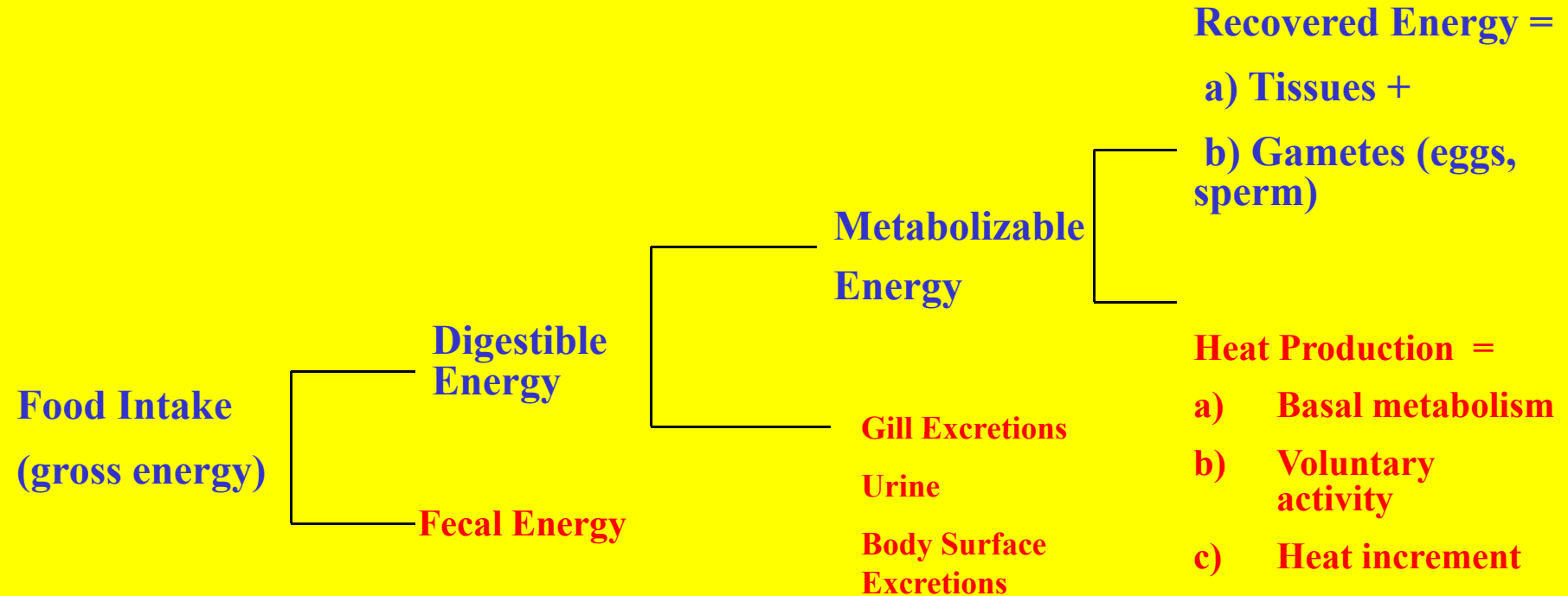
- **Fish do not maintain constant temperature** $1\frac{1}{2}$ lb feed = 1 lb fish
- **Better converters of foodstuffs**
- **Require less energy for body support**



Comparative Feed Use By Different Farmed Animals

Animal	Weight gain per gram of feed fed	Protein gain per gram of protein fed	Protein gain per unit of energy fed
Catfish	0.84	0.36	47
Chicken	0.48	0.33	23
Beef Cattle	0.13	0.15	6

The Energy Diagram

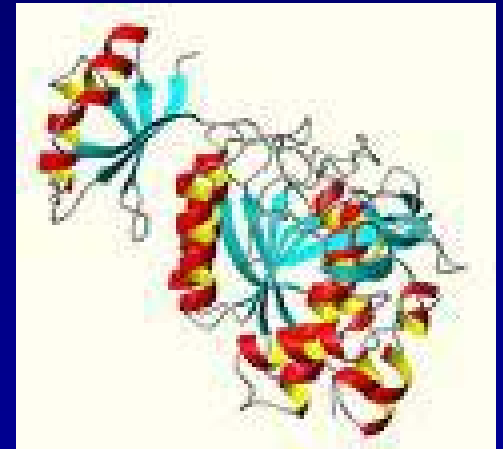


* Blue = Energy retained at each step

* Red = Energy lost at each step

Nutrient Requirements: All Fish

- **Proteins (essential amino acids)**
- **Used for: muscle, other tissues, enzymes, hormones, eggs and sperm**
- **Common sources: fish meal, poultry meal, soybean meal, meat and bone meal, cottonseed meal**



What Determines Protein Quality?

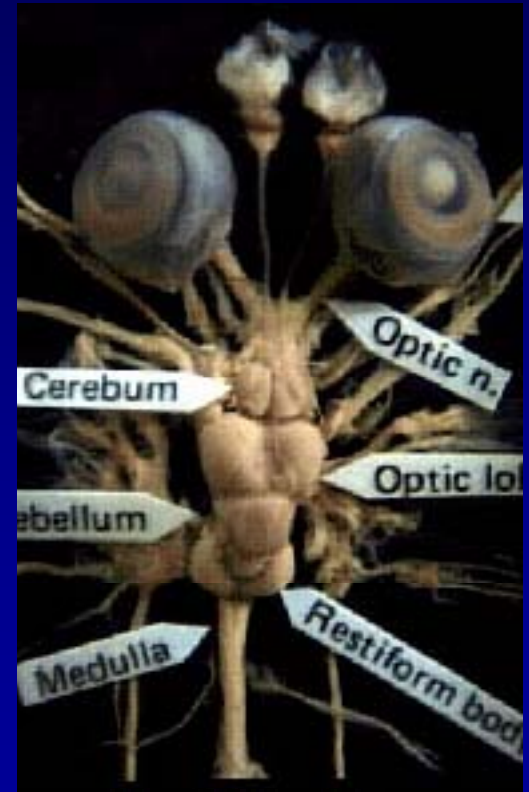
A high-quality protein source:

- **Contains all 10 essential amino acids**
- **Contains the correct proportions (not too much or too little of each)**
- **Amino acids are available (digestible)**



Nutrient Requirements: All Fish

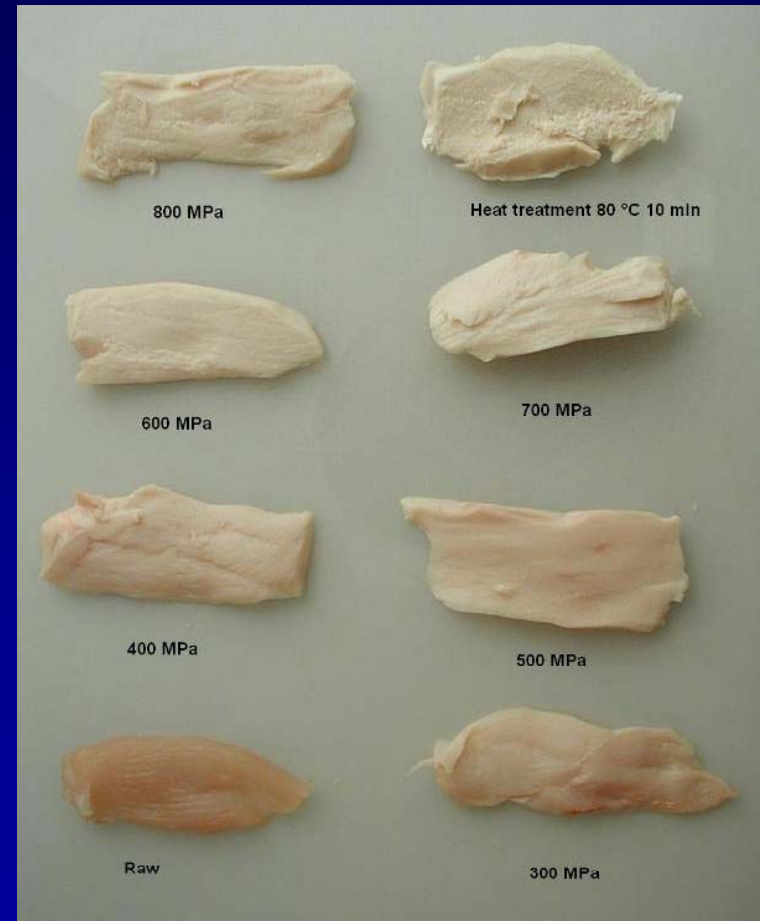
- **Lipids (fats) (essential fatty acids, carriers of fat-soluble vitamins)**
- **Used for: cell membranes, tissue structure & function (brain, eggs), lipid transport, production of hormones that function system-wide and locally**
- **Common sources: animal and vegetable fats (poultry, fish, soybean)**



What Determines Lipid Quality?

A high-quality lipid source:

- Contains both families of essential fatty acids (n-3 and n-6)
- No anti-nutritional factors (e.g., erucic acid)
- No oxidation products (not rancid)



Nutrient Requirements: All Fish

- **Vitamins – 2 categories**

- 1) **Fat-soluble**: Regulate the metabolism of structural units (e.g., vitamin D and bone metabolism)
- 2) **Water-soluble**: Function in energy transfer (& generation of energy from food)

* Usually added to catfish diets

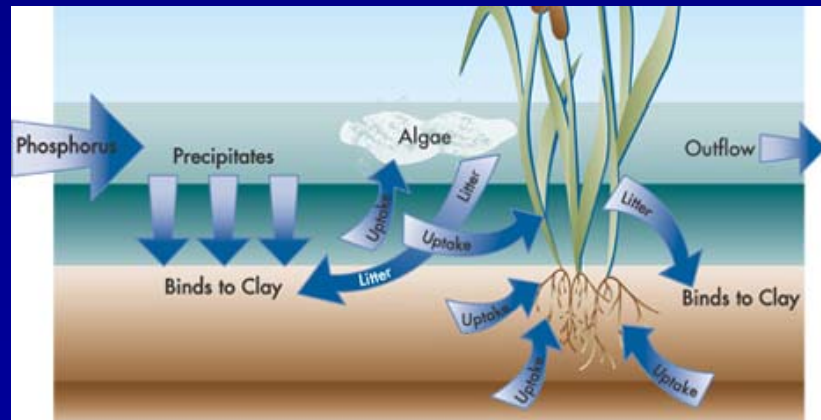


Nutrient Requirements: All Fish

- **Minerals – 2 categories**

- 1) **Macrominerals**: Structure of hard tissues, acid-base balance & osmoregulation, enzyme co-factors
- 2) **Trace**: Enzyme co-factors, antioxidant, cytochromes, thyroid function

Note: Fish can get some minerals from the water, but phosphorus is added to catfish diets



Other Nutrients: Not Required, but used in Catfish Diets

- **Carbohydrates: No essential factors**
- **Cheap energy source**
- **Needed to produce floating pellet (expansion of starch during extrusion)**
- **Only digestible carbs like starch can be an energy source**
- **Indigestible carbs (fiber) are excreted**



From Nutrient Requirements to Feed Formulations

- The essential nutrient requirements of catfish are known
- The requirements can be met by various combinations of feed ingredients
- **There is no single feed ingredient that supplies all required nutrients**



Sample 32% Protein Diet for Catfish

<u>Ingredient</u>	<u>Percent of Diet</u>
Soybean meal	35
Cottonseed meal	10
Fish meal	4
Meat/bone/blood	4
Corn	30
Wheat middlings	15
Fat	1.5
Other*	Include

*vitamins & minerals, binders

Source: Robinson and Li 2002

Same Diet With Fish Meal Removed

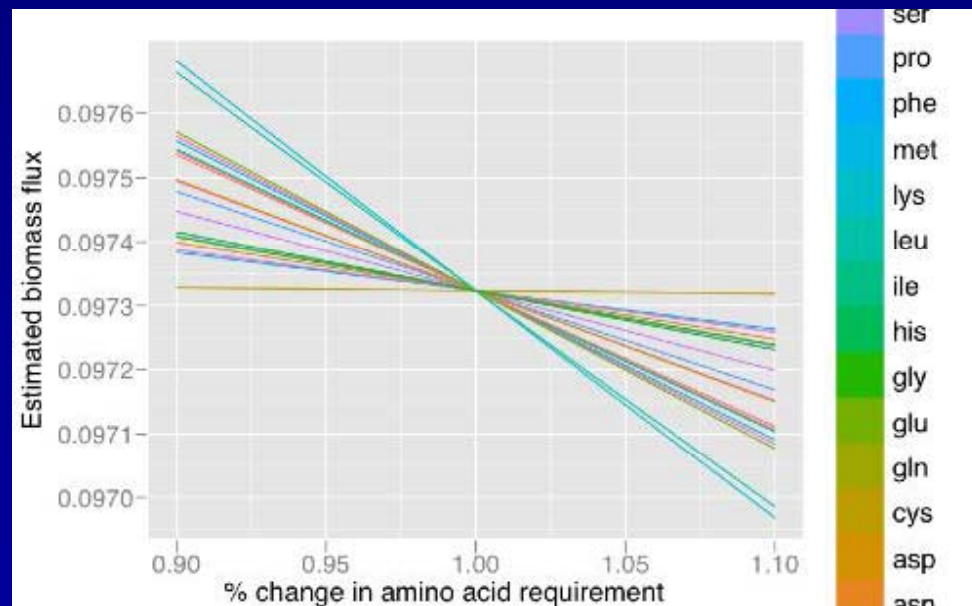
What Changes?

<u>Ingredient</u>	<u>% of Diet</u>
Soybean meal	35
Cottonseed meal	10
Meat/bone/blood	4
Corn	30
Wheat middlings	15
Fat	1.5
Other*	Include

- Lost 2.5% highly digestible protein
- Lost good source of lysine and methionine
- Lost digestible energy and phosphorus source
- Other? Palatability or growth factors?

Can We Restore Diet Quality Without Using Fish Meal?

- **YES! But diet ingredients are not interchangeable**
– each unique combination of ingredients must meet all of the nutrient requirements of the fish



Protein & Amino Acid Composition (%) of Major Protein Feedstuffs

<u>Ingredient</u>	<u>Protein</u>	<u>Lysine</u>	<u>Methionine</u>
Fish meal	64.5	4.72	1.75
Soybean meal	50	3.08	0.68
Cottonseed meal	41.2	1.89	0.50
Meat and Bone meal	50	2.67	0.65

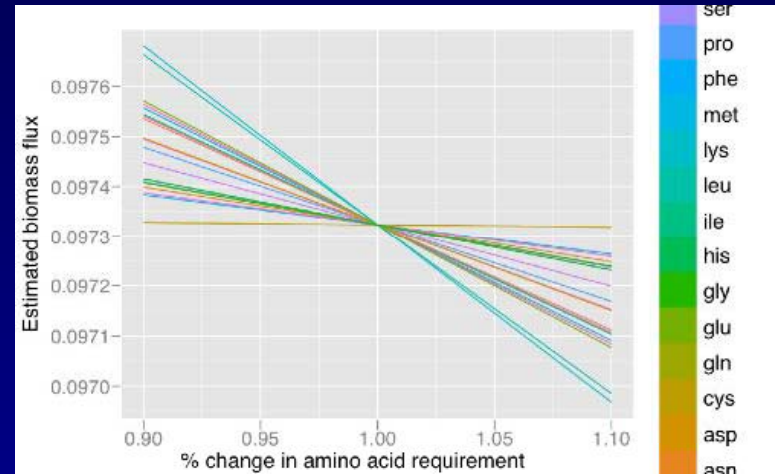
Protein and Amino Acid Digestibility (%) of Major Feedstuffs

<u>Ingredient</u>	<u>Protein</u>	<u>Lysine</u>	<u>Methionine</u>
Fish meal	82	82.5	80.8
Soybean meal	89	90.9	80.4
Cottonseed meal	82	66.2	72.5
Meat and Bone meal	73	81.6	76.4

Other Components of Protein Feedstuffs

Ingredient	Fat	Fiber	Ash	Digest. Carb
Fish meal	9.6	0.7	19	0
Soybean	1.1	7.3	6.3	31.3
Cottonseed	1.8	11.3	6.4	30.8
Meat/Bone	9.7	2.4	29.2	< 2%

Can We Restore Diet Quality Without Using Fish Meal?



32% Protein Diet – No Fish Meal

<u>Ingredient</u>	<u>Percent of Diet</u>
Soybean meal	34.6
Cottonseed meal	12.0
Meat/bone/blood	8.0
Corn	30.3
Wheat middlings	15.0
Fat	1.5
Other*	Include

*vitamins & minerals, binders

Source: Robinson and Li 2002

How Can You Compare the Quality of Different Diet Formulas?

- If specific feed formulas are proprietary, ask to see the feed mill's list of restrictions for the least-cost program(s) they use
- Example: Table 3 from MAFES Bulletin 1143 (Robinson and Li, Catfish Nutrition Research)

Restrictions for a 28%-Protein Diet

<u>Ingredient</u>	<u>Inclusion rate</u>
Protein	28 % (min)
Crude Fiber	7 % (max)
Lipid	6 % (max)
Available Phosphorus	0.3 - 0.4 % (min & max)
Digestible Energy	2.8 - 3.0 kcal/g (min and max)
Available Lysine	1.43 % (min)
Available Methionine	0.26 % (min)
Grains/by-products	25.0 % (min)
Cottonseed meal	15.0 % (max, w/o added Lys)
Fish meal, other anim.	3.0 % (max)
Xanthophylls	11.0 ppm (max)

Challenges

- **Least-cost feed formulations - meet all nutrient requirements with the most economical combination of ingredients – this changes constantly**
- **Still some gray areas – least-cost programs are effective if accurate and complete information is programmed in (ex, nutrient digestibility from each ingredient)**



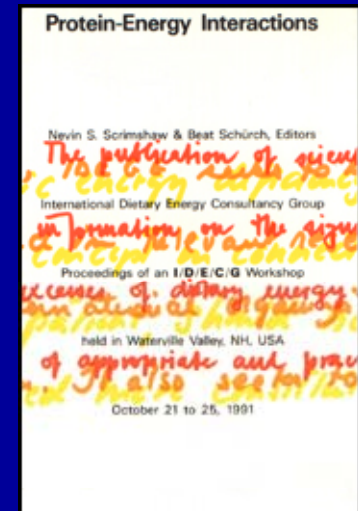
Challenges

- **Interactive effects among different feed ingredients are still not well-defined**
- **Example: Blood meal is high in iron that can oxidize other nutrients like vitamin C**
- **Example: High fiber content – as in plant ingredients – can reduce total digestible energy of the diet**
- **Example: Anti-nutritional factors such as phytate (binds minerals) may not be factored into programs**



Summary

- **Arm yourself with some basic facts about catfish nutrition and diet ingredients**
- **Nutrient requirements of fish (NRC, 1993) – is available free online**
http://www.nap.edu/openbook.php?record_id=2115&page=1
- **Contains tables of nutrient requirements of catfish and analyzed composition of common feed ingredients**



Summary

- We are continuing research to address diet quality/ overall effects on fish performance and economics
- Interactive & proactive approach with farmers, scientists and feed mills is needed!



Questions?

