

Aquatic Animal Nutrition  
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FISH 7640

Lecture 8  
Other Dietary Components

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**Other Dietary Components**

- In addition to the essential nutrients, feeds may contain organic and inorganic materials that have various effects on aquatic species:
  - beneficial, detrimental or negligible
  - they can affect growth, health or the processed product
  - may be naturally occurring, intentionally or unintentionally added
  - can be produced via microbial growth

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**Other Dietary Components**

- Fiber
  - Indigestible plant matter such as cellulose, hemicellulose, lignin and other complex CHO found in feedstuffs. Non-digestible component of the feed
  - Provides physical bulk in feed
    - Small amount probably good
    - High levels increased rate of passage causes reduced availability of nutrients, dilution of nutrients may reduce growth and FE values

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## Pigments

- Plants and animals contain a variety of natural pigments giving yellow, orange and red colors. Carotenoids most important group.
- Xanthophylls (oxygenated carotenoids)
  - Astoxanthin/cathoxanthin responsible for red coloration salmonids
    - Astoxanthin – primary pigment of wild salmon obtained from zooplankton.
  - Plants lutein (yellow) and zeaxanthin (yellow-orange)
    - These yellow pigments are considered undesirable (alfalfa, yellow corn and algae)
  - Availability and conversion varies with species

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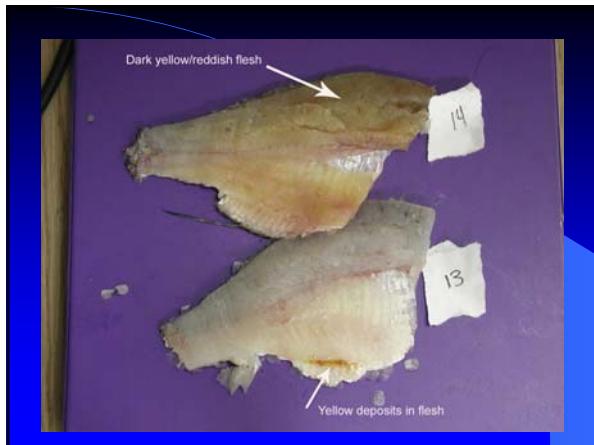
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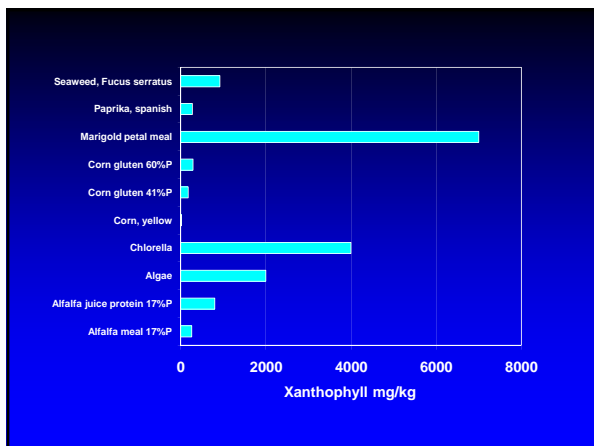
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## Attractants

- Attractants are materials added to feeds to serve as intake stimulants
- they are considered cost effective since they cause shrimp/fish to eat feeds that otherwise would not be attractive (consumed)
- usual inclusion level is around 0.5-1.0 %, largely due to cost
- examples: krill meal, Artemia meal, squid, shrimp head meal, fish oils, fish meal

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## Diet Additives: Hormones

- Hormonal control used to produce mono sex cultures of fish
- reduces reproduction/increases growth
  - ex. Androgenic steroids (ethyltestosterone) fed to tilapia fry = >90% males
    - does not work the same on all fish
  - 17-alpha-methyltestosterone improves growth and survival in salmonids

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## Antibiotics

- Some feeds can be formulated with antibiotics for treatment of bacterial infections such as Vibriosis
- Four antibiotics approved in U.S for fish:
  - Romet 30 (sulfadimethoxine + ormetoprim) and terrymycin (oxytetracycline). Sulfamerazine (not currently manufactured) Florfenicol
- oxytet commercially available as “medicated” shrimp feed, 1,500 mg/kg
- must have proper withdrawal period: e.g. do not feed medicated diets within 14-21 days from slaughter/harvest

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## Therapeutic agents

- After diagnosis
- Quarantined
- Suitable with drawl period should be observed
- Questionable use of therapeutic agents is excluding products from major world markets (e.g. Chloramphenicol)



<http://www.fda.gov/cvm/index/aquaculture/appendixa6.htm>

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## Binding Agents

- Binding agents are really needed for pelleted feeds, but not necessarily for extruded feeds.
  - In extruded feeds, CHO/proteins are gelatinized by high temperatures, moisture and bind the ingredients together.
- Increase stability, pellet firmness and reduce the production of fines

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Table 5.4. BINDING AGENTS USED IN STEAM PELLETTED FISH FEEDS

Compound	Amount used %	Comment
Carboxymethylcellulose	0.5-2.0	Good, expensive
Alginates	0.8-3.0	Good in moist feeds, must combine with di-or polyvalent cation
Polymethylcarbamide	0.5-0.8	Very good, not FDA approved for use in United States, unpalatable to some fish
Guar gum	1-2	Good, expensive
Hemicellulose	2-3	Fair, moderate cost
Lignin sulfonate	2-4	Good, moderate cost
Na and Ca bentonite	2-3	Inferior to organic binders
Molasses	2-3	Fair, has nutritional value
Whey	1-3	Fair, has nutritional value
Gelatinized starches (corn, potato, sorghum, rice, cassava)	10-20	Good, large amount required, has nutritional value
Wheat gluten	2-4	Good, expensive

(Lovell, page 118)

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## Binding Agents

- Cereal grains provide starch which when gelatinized gives a durable water stable pellet, however it will hydrate and swell the pellet.
- Chemical binders (e.g., **Basfin**) have good binding potential, form cross-linkages with COH and PRO, but are toxic at high levels

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## Pellet Binders

- Steam pelleted aquatic feeds, especially those fed to shrimp, contain binders
- these are used for improving water stability (reduced leaching and nutrient loss)

Table 6. Comparison of all binders.<sup>1</sup>

Binders	Percent dry matter loss 1 hr
Campan Plus	6.64 ± 0.08a
RE 9556/9557	7.22 ± 1.07ab
EC-6820	7.64 ± 1.17ab
Aquabind	7.69 ± 1.14ab
Campro	7.99 ± 1.35bc
EC-5819	8.14 ± 0.71abcd
AS-2000	8.21 ± 0.89abcd
NutriBex 40 Mega	8.40 ± 0.96bcd
Basfin	8.91 ± 0.27cde
Pel-Plus 250A	8.95 ± 0.85cde
RZ 9556	9.18 ± 0.64de
Pel-Plus 100	9.62 ± 0.82ef
Nutri-Binder	9.87 ± 1.40ef
D-507	9.97 ± 0.71ef
AP-520	10.00 ± 1.55ef
Aquaform 2A	10.46 ± 1.13f
Aquaform 1A	11.88 ± 0.74g

<sup>1</sup> % dry matter loss in 2 hr

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## Toxins and Anti-metabolites

- Anti-nutrient: naturally occurring substances that inhibit performance. Trypsin inhibitor, hemagglutinating agents, phytic acid, gossypol, cyclopropenoic fatty acids, glucosinolates, erucic acid, alkaloids and thiaminase.

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## Toxins and Anti-metabolites

- Anti-nutrient:
  - **Trypsin inhibitor**: Raw soybeans contain a globular protein that irreversibly binds to trypsin. Destroyed by heat processing.
  - **Phytic acid** – common in feedstuffs of plant origin. It is an organic molecule related to inositol holds 60-70% of the phosphorus.
    - P has low availability
    - reduces availability of P, Mn and Zn

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## Toxins and Anti-metabolites

- Anti-nutrient:
  - **Gossypol**-Found in the pigmented gland of cotton and may account for 2.4% of seed weight. Glandless cotton has reduced levels
    - Depresses growth, damages various organ tissues (kidney, liver) and is considered a carcinogen.
    - Solvent extracted cotton seed meal 400-800 mg free gossypol/kg)

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## Microbial Toxins in Commercial Fish/shrimp Feeds

- Usually not known that the feed is contaminated
- commercially-processed feeds are less likely to have these toxins
- screened against international transport regulations and by feed manufacturers by law
  - e.g. aflatoxins must be less than 20 ppb
- up to manufacturer to require testing

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## Toxins

- The more important toxins affecting animal feeding are those associated with molds and are called “**mycotoxins**”
- three important genera are *Aspergillus*, *Penicillium* and *Fusarium*
- they exist and grow anywhere as long as there is enough COH substrate, no less than 14% moisture, adequate temperature, oxygen
- usually produced in feedstuffs prior to harvest, but also result from poor storage

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## Aflatoxin

- **Aflatoxin** is the mycotoxin of greatest concern in feeding of culture species
  - both outright toxic and carcinogenic
  - Poor growth, liver damage, blood clotting problems, reduced immune response, increased mortality
  - not destroyed by steam pelleting or extrusion
  - presence in feeds reduced by **propionic acid**
- rainbow trout are highly sensitive at 1 ug/kg exposure
- All grains are subject to contamination: corn, cottonseed and peanuts
- aflatoxin contamination varies year to year

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## Ochratoxin

- These are compounds produced by *Aspergillus* and *Penicillium* molds
- widely found in nature
- typically associated with kidney toxicity
- toxic level is 4.7 mg/kg in diet
- other mold toxins have been found in warm-blooded animals, but not in fish
- most mold toxins also destroy nutrients in feeds
- example: *Pseudomonas* can separate glutamic acid from folic acid, making it ineffective

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### Biogenic amines: Histamine, etc.

- This is a toxic compound found in fish meal, a typical feed ingredient
  - results from bacterial removal of COOH (carboxylic acid) from the EAA histidine
- comes from improper storage of raw fish prior to production of fish meal
  - causes a reduction in growth rate
  - usually comes from “dark” meat portion of fish
- other fish meal toxin is “gizzerosine”

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### Fish Oils

- Marine fish oils contain 20-25% PUFA's
  - the “autoxidation” of PUFA's results in formation of large numbers of free radicals and peroxide compounds
  - these are toxic due to reaction with other nutrients, limiting availability
  - also cause cellular/subcellular damage
  - severity of effect reduced by Vit E

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### Antioxidants

- Oxidation of lipids in feeds or feedstuffs can cause reduction of the nutritional value of certain lipids and vitamins
  - it can also result in production of toxic free radicals and peroxides
- potential for formation of these toxic compounds reduced by synthetic compounds such as **BHA, BHT** (0.02% of fat) or ethoxyquin 150 mg/kg feed
- also via natural compounds (Vit E)

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