Nutrients

AG 240
What are the 6 Nutrients

- Carbohydrates
- Proteins
- Fats/Oils (Lipids)
- Vitamins
- Minerals
- Water
Carbohydrates (CHO)

- Primary component of livestock feed
  - Referred to as “energy”
CHO Characteristics

- Structural part of plant
- Makes up 75% of plant’s dry weight
- Largest portion of ruminant’s diet
- Formed in photosynthesis
- Fermentation needed to digest cellulose
# Types of Carbohydrates

<table>
<thead>
<tr>
<th>Type</th>
<th>Feedstuff</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starches</td>
<td>Corn</td>
<td>Energy source</td>
</tr>
<tr>
<td>Sugars</td>
<td>Molasses</td>
<td>Palatability</td>
</tr>
<tr>
<td>Cellulose</td>
<td>Hay</td>
<td>Cell Walls</td>
</tr>
</tbody>
</table>
Categories of Carbohydrates

- **Monosaccharide**
  - Simple Sugars
    - Glucose, Fructose, Galactose

- **Disaccharides**
  - Two simple sugars
    - Sucrose, Maltose, Lactose

- **Oligosaccharides**
  - Yields 3-6 monosaccharides when broken down
Categories of CHO con’t

- Polysaccharide
  - Yields more than 6 simple sugars (monosaccharides)

- Mixed Polysaccharide
  - Mono and disaccharides

- Lignin
  - Not always considered to be a CHO
Closer look at Disaccarides

■ Sucrose
  – 1 glucose + 1 fructose
  – Table sugar (cane or beet)
  – Sucrase is related enzyme

■ Maltose
  – 2 glucoses
  – Bread sugar
  – Maltase is related enzyme
Disaccarides con’t

- Lactose
  - 1 glucose + 1 galactose
  - Milk sugar
  - Lactase is related enzyme

- Cellobiose
  - 2 glucoses
  - Cellulase is related enzyme
Types of Polysaccharides

- **Starch**
  - Stored in plants
  - Alpha link of glucose
    - Amylase can break alpha links

- **Cellulose**
  - Beta linkage of glucose
    - Amylase can not break beta bond
    - Bacteria/micro-organisms can break beta bond
  - Fibrous, tough, water insoluble material found in plant cell walls
  - Makes up bulk of ruminant’s diet
Digestive reactions

- **Fast reactions**
  - Starch → Maltose → 2 glucoses
    - Amylase
    - Maltase

- **Slow Reaction**
  - Cellulose → Cellobiose → 2 glucoses
    - cellulase
    - Produced by cellulolytic microbes
Types of Mixed Polysaccharides

- **Hemicellulose**
  - More digestible than cellulose
  - Still have beta linkage

- **Pectins**
  - More digestible than hemicellulose
  - Still has beta linkage

- **Gums**
Notes on Lignin

- Not always considered to be a CHO
- High % lignin decreases digestibility
- Found in plant walls (like stems)
  - Higher in legumes than grasses
  - Lignin content increases with age
Review Categories of CHO

- Monosaccharide
- Disaccharides
- Oligosaccharides
- Polysaccharide
- Mixed Polysaccharide
- Lignin
Functions of CHO

- Source of energy
- Source of heat when metabolized
- Building block (sugar)
- Can store in body as fat
CHO Deficiencies in body...

- Dietary Ketosis
- Diabetes Mellitus
CHO, Plants and Animals

- Cereal grains are high in starches
  - Amylase can break down starch
- Forages are primarily cellulose
  - Microbes required to break down cellulose

- When the CHO level in the diet exceeds the ability of an animal to digest it, diarrhea may occur
CHO and VFAs

- VFAs are absorbed by rumen into bloodstream
- VFAs are metabolized into glucose in liver and other tissues
### VFAs and CHO sources

<table>
<thead>
<tr>
<th>Diet</th>
<th>Acetic</th>
<th>Propionic</th>
<th>Butyric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roughage</td>
<td>65-85%</td>
<td>10-15%</td>
<td>5-15%</td>
</tr>
<tr>
<td>Concentrates</td>
<td>30-50%</td>
<td>30-60%</td>
<td>10-20%</td>
</tr>
</tbody>
</table>
Questions related to CHO

- Why do we feed Ionophores (Rumensin and Bovatec)?
- Why are high corn diets fed in feedlots?
- Why are high roughage diets fed to lactating cows?
Fats/Oils (Lipids)

- Def: Organic substance insoluble in water
- Energy dense
  - 1 gm fat = 9.45 kcal of energy
  - 1 gm CHO = 4.2 kcal of energy
  - Thus fat is 2.25 more energy dense than CHO
- AKA Triglyceride
  - 3 fatty acids and a glycerol
Classification of Fats

- Saturated
- Unsaturated
Saturated Fats

H-C-H

- Definition:
  - All of the carbon atoms are associated with 2 Hydrogens connected with single bonds.

- Examples:
  - Acetic
  - Propionic
  - Butyric
  - Stearic
Unsaturated Fats

- **Definition:**
  - One or more pairs of the C atoms attached by double bond; H is removed

- **Examples:**
  - Linoleic
  - Linolenic
Fats versus Oils

- **Fats**
  - Solid at room temp
  - Contain saturated (long chain) fatty acids

- **Oils**
  - Liquid at room temp
  - Contain unsaturated (short chain) fatty acids
  - Absorbed more completely than fats
You are what you eat….

Monogastrics are very sensitive to what kind of fats/oils are in their diet

Source: Livestock Feeds and Feeding (Cheeke)
Functions of Fats/Oils

- Dietary energy source
- Source of heat
- Insulation and protection of organs
- Source of essential fatty acids (EFA)
- Carrier for fat soluble vitamins
- Precursor of steroid hormones
Essential Fatty Acids (EFA)

- Def: Fatty acids that the animal requires but can not synthesize inadequate amounts
- Monogastric
  - 1% of diet
  - Linoleic and Linolenic
  - Corn and SBM are excellent sources
- Ruminant
  - No EFAs
  - Produced by micro-organisms
Final Notes on Fats/Oils

- Most plants have 2-8% fat
  - Soybean, cotton and sunflower seed have over 20%

- Animals can only handle 5% fat in diet
  - Range is generally 2-8%

- Digestibility can be as high as 80-90%
  - But….remember bacon picture
Protein Characteristics

- Only nutrient class that contains Nitrogen (N)
- Requirements highest in young animals
- Made up of Amino Acids
- Rumen microbes manufacture protein
Protein Terminology

- **True protein**
  - Protein composed only of amino acids

- **Nonprotein nitrogen (NPN)**
  - Not true protein in nature but contains N and can be converted to protein by bacteria
    - Urea is an example

- **Crude protein**
  - Protein composed of true protein and any other nitrogenous product
Protein Terminology con’t

- Digestible protein (DP)
  - Portion of the CP which animal can digest

- Essential amino acid (EAA)
  - Those AA that are essential to the animal and must be supplied in the diet

- Nonessential amino acid
  - Those AA that are essential to the animal but are normally synthesized or sufficient in the diet.
Ruminants and Protein...

- Ruminants have the ability to convert low quality feed protein into higher quality microbial protein that better meets the animal’s needs.
Protein utilization by ruminant

- 60% of feed proteins are broken down into AA and then to ammonia (NH3)

- 40% is not broken down and simply passes on through
  - This protein is called ‘bypass or escape’ protein
Feeding NPN

- Feed only to ruminants!!

- Sources
  - Urea and Anhydrous ammonia
    - Both are very soluble and convert to ammonia very quickly
Guidelines for NPN

- Be careful about how much we feed
  - Excess ammonia is absorbed from the rumen, converted to urea by liver and excreted by the kidneys
    - Ammonia buildup can sicken or kill animal

- Need to feed CHO with NPN
  - Needs carbon skeletons to create protein from NH3
Essential Amino Acids

- Animal can’t synthesize them fast enough to meet requirement, so must come from diet
- 0 essential AA for Swine; 12 for Poultry

- PVT TIM HALL
Phenylalanine
Valine
Threonine
Tryptophan
Isoleucine
Methionine

Histidine
Arginine
Leucine
Lysine
Specie notes on EAA

- Glycine - poultry EAA
- Proline - poultry EAA

- Mature pigs do not need
  - Histidine
  - Arginine
  - Leucine
Notes on EAA

- Most common missing AA
  - Lysine
  - Methionine
  - Tryptophan

- Why:
  - Corn and milo are low in these amino acids
  - Feed with SBM b/c contains these three AA
Final notes on Amino Acids

- Also have non-essential amino acids
- Ruminants can synthesize all of them in rumen
  - Only limiting AA is Lysine
Functions of Proteins

- Basic structural part of body
  - Collagen, keratin, blood protein
  - Building blocks of body: Hair, skin, muscle, blood, organs

- Body metabolism
  - Enzymes, Hormones, Immune system (antibodies are proteins), DNA

- Source of energy
Notes on Protein

- Most sources are 75-80% digestible
  - Varies with feedstuff
- Protein quality is less important to ruminant animals
- Quantity and quality of protein varies with feedstuff
  - Quantity (amount) decreases with age
Vitamins
## Natural Sources of Vitamins

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Carotene rich plants; green leafy forages, hays or silages, yellow corn, whole milk; fish oils</td>
</tr>
<tr>
<td>D</td>
<td>Fish liver oils, sun-cured hay</td>
</tr>
<tr>
<td>E</td>
<td>Seed germ or germ oils; green forage or hay</td>
</tr>
<tr>
<td>K</td>
<td>Green forage; well cured hay; fish meal</td>
</tr>
<tr>
<td>thiamine-B1</td>
<td>Green forage; well cured hay; cereal grains; brewers yeast</td>
</tr>
<tr>
<td>riboflavin-B2</td>
<td>Green forages, hay or silage; milk products, meat or fish meal, distiller’s products</td>
</tr>
<tr>
<td>Pantothenic acid</td>
<td>Brewer’s yeast; liver meal; dehydrated alfalfa meal; fish soluble; most any feedstuff</td>
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</tbody>
</table>
The END!
Factors affecting rate of protein degradation

- Solubility of feedstuff protein
- Rate of passage