Chap 6: Animal Nutrition and Feeding

1. Nutrients

1.1. Water

- Difference between water & moisture
- Dry matter
- Most important nutrient!
- Functions
    - Metabolic reactions
    - Transport nutrients
    - Temperature maintenance
    - Physical shape of the body (cell contents)

2. Carbohydrates

- Found in plant & animal tissue
- Simple carbohydrates
    - Starch
        - Easily digested
        - High in energy
- Complex carbohydrates
    - Cellulose, lignin
        - Energy source
        - Present in cell walls

3. Fats

- Includes oils
- A.K.A. lipids
- Fats are solid, oils are liquid at room temp.
- 2.25x more energy/lb. than carbs.
- >100 fatty acids identified
    - Linoleic, and α-Linolenic are essential in livestock diets
        - Precursor of prostaglandins & cell structure

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5. **Essential Amino Acids**
     - Must be supplemented in the diet
       - Feed
       - Microbial protein
6. **Nonessential Amino Acids are synthesized by the body**
   - Various absorption rates
     - Egg
     - Animal
     - Plant
7. **Minerals**
   - Chemical elements other than carbon, hydrogen, oxygen, nitrogen
   - Macrominerals
     - Required in larger amounts
     - Ex.?
     - Important for several major bodily functions
   - Micromineral
     - Trace minerals, required in small amounts
     - Ex.?
     - Important for vitamins, hormone synthesis
   - Usually work together w/ other nutrients
   - Can be harmful in high levels
8. **Vitamins**
   - Organic nutrients required for very specific bodily functions
   - 16 vitamins
     - Fat soluble

- A, D, E, K
- Water soluble
- C, B12, B1, Niacin
- In ruminants, these are synthesized by the microorganisms

2. Feeds analysis

2.1. Proximate Feed Analysis

Separates feed components into group according to feed value

Accuracy of the analysis is dependent upon accuracy of the sample

Components measured

2.2. Water

- Crude protein
- Crude Fat
- Crude Fiber
- Nitrogen-free extrac
- Ash (minerals)

2.3. Determining moisture and/or DM content

2.4. Feed Digestibility

- Amount of a feed that is absorbed from the digestive tract
- Measuring digestibility

2.5. Energy Evaluation of Feeds

- Energy is available in any nutrient with carbon
- Carbs., protein, fats

  - Measuring energy
    - TDN
      - Not as accurate
    - ME
      - Very accurate
      - NE
      - DE
  - Calorie (cal)
    - Energy required to raise the temp of 1g of water 1 degree C
  - Kilocalorie (kcal)
    - Energy needed to raise the temp of 1kg water 1 degree C
  - Megacalorie (Mcal)
    - =1,000 kcal or 1,000,000 cal

- Some energy is lost, and therefore not digested
    - Feces
    - Urine
    - Gases
    - Heat
    - Animal uses energy in two ways
        - Maintenance
        - Production
    - GE
        - Amount of heat (cal) released from complete burning of a feed (Bomb Calorimeter)
    - ME is what the animal actually has the opportunity to use
        - NE is what is available after energy used for consumption, digestion, metabolism **(heat increment)**

3. Feeds and feed consumptions

3.1.Classification of Feeds
3.1.1. Dry roughages & forages
3.1.2. Hay

3.1.3. silage

3.1.4. Straw

3.1.5. Others

3.2.Range, pasture, green forage

3.3.Silages

3.4.Energy Feeds >18% CF, <20%CP

3.5.Protein supplements >20% CP

3.6.Mineral supplements

3.7.Vitamin supplements

3.8.Nonnutritive additives

3.9.Antibiotics

3.10. Coloring

3.11. Flavors

3.4. Digestion and feed absorptions

Digestion

- Mechanical
- Chemical
- Role is to produce feed particles the can be absorbed and used by the body

- Types of animals
- Carnivores & Omnivores are monogastric animals
  - One, simple stomach
  - Also some herbivores (horse, rabbit)
- Herbivores
  - Ruminants
  - Stomach compartments

3.4.1. Monogastric digestive tract

- **Mouth**
  - Mechanical chewing and swallowing of food
  - Salivary Glands
- **Esophagus**
  - Delivery tube from mouth to stomach
  - Valve controls opening
- **Stomach**
  - Primary area of reduction in feed particle size
- **Small intestine**
  - **Duodenum**
  - **Jejunum**
  - **Ileum**
  - **Split molecules & absorb nutrients**
- **Large intestine**
  - **Cecum**
  - **Colon**

- **Absorb water**
- **Forms indigestible waste (Feces)**

3.4.2. Digestion in monogastrics

- Begins in the mouth
- Enzymatic reactions
    - Organic catalyst that speeds a chemical reaction without being altered by the reaction
    - Stomach secretions
        - HCl
        - Mucus
        - Pepsin
        - Gastrin
- Mixture and some digestion occurs, resulting in Chyme
- Amino acids, fatty acids, and monosaccharides are available for absorption
- Two methods of absorption
    - **Passive**
        - Molecules diffuse from high concentration area to low concentration
    - **Active**
        - Engulf molecules in villi, and transport them to bloodstream or lymph
- Liver function
    - Metabolizes feed particles in bloodstream
    - Detoxifies harmful substances

3.4.3. Ruminant digestive tract

- **Rumen**
    - Fermentation vat
    - Papillae
    - Bacteria & protozoa
- **Reticulum**
    - Aka honeycomb
    - Initiate mixing in rumen

- **Omasum**
  - Many folds (manyplies)
  - Grinding action?
  - Not a lot of digestive responsibility
- **Abomasum**
  - **True stomach**

Ruminants can rechew feed already consumed for more thorough breakdown of feed particles (Cud) known as rumination

Elimination of gases by eructation

3.4.4. Digestion in Ruminants

- **Fermentation in rumen & reticulum**
  - Microorganisms number in the billions
  - Excess are removed with feed movement and killed by acid in the abomasum
  - Mutually beneficial relationship
- **Digestion is the same after feed reaches the abomasum**
- **Microorganisms use starch and sugar for their growth and development**
  - Robs the animal of valuable energy sources
  - Produce Volatile Fatty Acids (VFA) which the animal absorbs and converts to energy
    - Acetic
    - Propionic
    - Butyric
  - **Methane gas is released through eructation**
    - What if this action fails

- Esophageal groove
  - Pathway directing milk to abomasum
- Complete function of digestive tract is not complete until:
  - Sheep ~2 mos.
  - Cattle ~3-4 mos.
  - Influenced by feed type
- Energy Pathways
  - End products of glucose and fatty acids supply body tissues with energy, and become milk fat and lactose in the lactating ruminant

- **Primary organs and tissues in energy metabolism**
    - Rumen
    - Abomasum
    - Small intestine
    - Liver
    - Blood vessels
    - Mammary gland
    - Body tissue
- **Undigested energy products**
    - Complex carbos. (lignin) and other (ex. Ketone bodies)
    - Excreted through large intestine or kidneys

- **Protein Pathways**
    - End products of protein and NPN:
        - Amino acids
        - Ammonia
            - Excess formed into urea in liver and excreted in the urine
            - Some is returned to the rumen
        - **Synthesized amino acids**

3.5. Ration formulation

- Objective is to economically match the animal's nutrient requirements with available feeds
- Things to consider:
    - Palatability
    - Physical form
    - Other