ANSC3101 Animal Nutrition

Lecture 14: Manipulating the rumen microbiota to improve ruminant production

Recap

- Biofilms are resilient, they form on the surfaces. Once a biofilm form, it is so hard to manipulate.
- If the pathogen (bacteria) is present in the form of biofilm, it will take 1000 more antibiotcis to get rid of the bacteria (especially when the pathogen is in the dormancy state within the biofilm)
- Antibiotics do not have direct contact to the bacteria that is why it is so hard to clear the pathogen (manipulation is hard)

Dietary additives (to manipulate the rumen system) include:

- Tannins, phenolics and **essential oils**
- Tasco seaweed
- Citrus products
- Organic acids
- Probiotics (bacteria and yeast)
- Direct fed microbials (similar to probiotics)
- Bacteriocins (peptide of protein with any micro-bacterial activity, e.g. bacillus)
- Pre-biotics (in the diets → to promote the rumen bacterial population)

In nature, essential oils play an important role in the protection of plants. Essential oils contain a wide variety of secondary metabolites that are capable of inhibiting or slowing the growth of bacteria, yeasts and moulds. Essential oils and their components have activity against a variety of targets, particularly the membrane and cytoplasm, and in some cases, they completely change the morphology of the cells.

Essential oils: composition

- There is a wide variation due to:
    - Part of the plant (e.g. seeds vs leaves)
    - Growing conditions (climate, soil, etc)
    - Health of the plant (e.g. insect attacks) → if there is an insect attack this may change the composition or concentration of that essential oil due to the defence mechanism against the insect
    - Plant processing (some of the essential oils would be broken down due to the heat or method)
    - Method of extraction (steam vs solvent)
    - Botanical species

There are several mechanisms of action of essential oils on bacteria.

- Some are lipophilic meaning that they are able to accumulate in the lipid bilayer of the plasma membrane and disrupt the cell membrane structure (e.g. terpenes)
- Some may disrupt the ion gradients across the plasma membrane, leading to the dissipation of ATP OR limiting cell growth or even causing bacterial cell death (e.g. carvacrol)
- Interacting with proteins, either within the plasma membrane or within the cytoplasm itself. The interaction can affect the bacterial cell metabolism. (e.g. cinnamaldehyde)

Some microbes can survive through harsh conditions. When some of them expose to essential oils, they would change the metabolic machinery to adapt to the changed environment. Some of them would then develop resistance to essential oils, due to that property this could also increase resistantance to antibiotics.
→ antibiotics resistance does not necessarily directly be caused by the consumption of antibiotics

The major effect of essential oils on rumen energy metabolism is to improve efficiency of energy utilisation through:

- Increase of propionate production

Lecture 23: Fat soluble vitamins

Fat soluble vitamins are **grouped together based on solubility**. There are many **different structures and function**s. They can **interact (share absorption mechanisms) with other fat soluble vitamins and minerals**. They are **variable in body storage** and can be **toxic** if there is an **excess** amount in body.

Vitamins A (aka retinol)

- Characteristics:
  - Pale yellow crystalline solid
  - Insoluble in water but **soluble in fat and fat solvents**
  - Destroyed by **oxidation** on exposure to air and light
  - **Accumulates in the liver**
  - Cod liver oil
  - **High** content of vit A can be found in **soup fin shark** (15000 ug/g liver) > polar bear (6000) > halibut (3000) > codfish (600) > horse (180) > human (90) > pork (30)
- Vitamin A is a provitamin (a substance which is converted into a vitamin within an organism), it presents in **plants** as carotenoid precursor (carotenoids have red, yellow, orange colours → masked by chlorophyll in plants)
  - can also be found in egg yolk, butterfat, body fat of cattle and horses (not sheep or pigs)
  - B carotene forms the main source of vitamin A in the diets of farm animals
  - Easily oxidised to no activity forms
  - Oxidation is increased by heat, light and moisture
  - Large losses can occur during storage (sun drying of crops)
  - Fresh grass is a rich source (not silage)
  - Conversion of carotene to vitamin A can occur in the liver and small intestine
- Toxicity
  - **Hypervitaminosis** (excess vitamin A) rarely occurs due to food intake, usually caused by supplementation excess
  - Can be Acute vitamin A toxicity or Chromic vitamin A toxicity
  - Babies and children more susceptible
- Functions
  - Eye → Cyclical conversion in retinal cells of the eye is responsible for the ability to see in low light intensities (eat your carrots!)
  - Rest of the body → Regulation of cellular differentiation; Formation and protection of epithelial tissues and mucous membranes; Growth, reproduction and immune response; Scavenger of free radicals
- Deficiency symptoms in human
  - Night blindness
  - Susceptibility to infection
  - Severe deficiency unlikely in adult animals (except after prolonged deprivation)
  - Skin, eye, reproduction problems
  - Importance of colostrum:
    - In some species placental transfer of immunoglobulins takes place prior to birth (humans); Other species rely upon colostrum (first few days milk)
    - Immune enhancement demonstrated in all mammals – contains antibodies and growth factors
    - These factors have optimal absorption in the neonate in the first few days after birth
    - Pinocytosis 'cell eating' ability stops after the first three or so days
    - Survival ability greatly decreased if lambs, calves, foals do not receive colostrum
- Deficiency symptoms in animals
  - Cattle → Rough hair, scaly skin, eye problems, blindness in calves, infertility, reproductive problems