Ketosis

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Lesson - I

Defenition, Importance of Keosis, Etiology of Ketosis

Unit : Ketosis

Lesson : 1

Defenition, Importance of Keosis, Etiology of Ketosis

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Ketosis – Defenition

- It is defined as a multifactorial disorder of energy metabolism
- A basic metabolic disturbance resulting from negative energy balance during lactation, a reduction of glucose in the blood and liver and an increased fat mobilization that results in elevated ketone body accumulations

- Characterized by abnormally elevated concentrations of the ketone bodies and hypoglycemia
- Ketone bodies include acetoacetic acid , acetone and β - hydroxybutyrate

Importance of Ketosis

Selection of milch animals for high milk yield results in elevated milk production during early lactation

Increase in milk production exceeds the capacity of the animal to ingest sufficient feed to meet requirements for energy

Net result is negative energy balance – mobilization of body fat and protein – TG and amino acid – gluconeogenesis and ketogenesis

Importance of Ketosis

Certain degree of ketosis is a natural state in ruminants

Cows partition nutrients during pregnancy and lactation and are in a lypolytic stage in early lactation and are at risk for ketosis during this period

Ketosis becomes a disease condition when the absorption and production of ketone bodies exceeds their use by the ruminant as an energy source resulting in elevated blood ketones free or nonesterified fatty acids (FFAs) and NEFAs

Glucose Metabolism

Maintenance of adequate concentration of glucose in the plasma is critical for regulation of energy metabolism.

Ruminants absorbs very little carbohydrate as hexose sugars as carbohydrates are fermented in the rumen to short chain fatty acids - acetate (20%), propionate (20%) and butyrate (10%). Hence glucose requirement is largely met by gluconeogenesis.

Propionate and amino acids are the major precursors for gluconeogenesis.
Glycerol and lactate are of less importance.

Glucose Metabolism

Propionate

Most important glucose precursor
produced in the rumen from starch fiber and proteins
Enters the portal circulation and is efficiently removed by the liver
Production is favoured by inclusion of high grain in the diet

Amino Acids

Glucogenic

Important precursor for gluconeogenesis

Dietary protein is the most important quantitative source

Labile pool of body protein particularly skeletal muscle is also an important source

Contribute for energy synthesis, milk lactone synthesis and milk protein synthesis

Energy Metabolism

High producing dairy cows are in negative energy balance in the first few weeks of lactation

Highest dry matter intake does not occur until 8 to 10 weeks after calving

But peak lactation is at 4- 6 weeks. Hence the energy intake may not keep up with the demand

In response to negative energy balance and low serum glucose concentration (consequently low serum insulin)

Cows will mobilize adipose tissue with consequent increase sin nonesterified fatty acids (NEFA)

Subsequent increases in serum concentrations of β - hydroxybutyrate (BHB), acetoacetate and acetone

Hepatic mitochondrial metabolism of fatty acids promotes both gluconeogenesis and ketogenesis

Ketone Formation

Butyrate in rumen	Rumen fermentation of the diet converted to β-hydroxybutyrate in the rumen epithelium and absorbed as such
Mobilization of fat	Mobilized fat transported to the liver, oxidized to acetyl CoA and NADH

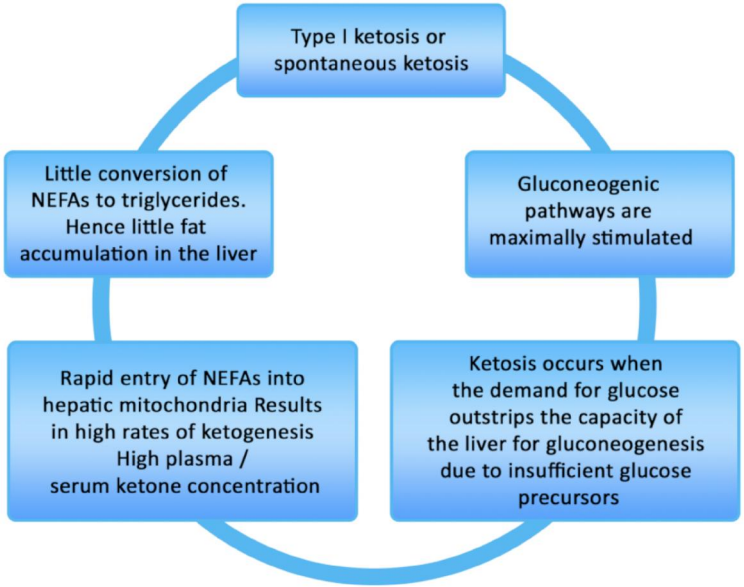
Ketone Formation

Acetyl Co A is oxidized via TCA cycle	Oxidation requires adequate supply of oxaloacetate from the precursor propionate
Metabolized to acetoacetyl Co A	Propionate deficiency- oxaloacetate deficiency- limited oxidation of acetyl CoA – metabolized to acetoacetyl CoA – acetoacetate and BHBA

Hepatic Insufficiency and Types of Ketosis

- Uptake of fatty acids by the liver leads to fatty liver – hepatic insufficiency
- Occurs in cows predisposed to ketosis by overfeeding during dry period

Types of Ketosis



TYPE II

Gluconeogenic pathways are not maximally stimulated

So NEFA uptake is not active

- NEFAs become esterified in the cytosol forming triglyceride
- Capacity of cattle to transport triglyceride from the liver is low
- Resulting in accumulation and fatty liver

Fatty liver further depresses gluconeogenesis

Type iii Ketosis

Animals fed with high butyrate producing diet

- **As excess butyrate is produced directly in the rumen**

  E.g. Maize

Role of Insulin and Glucagon

- Insulin and glucagon – regulates the energy metabolism in ruminants
- Counteracting effects play a role in the homeostatic control of glucose
- Low insulin glucagon ratio – stimulates lipolysis – adipose tissue and ketogenesis in the liver
- Cows in early lactation have low insulin and glucagon ratio

Subclinical Ketosis

- Elevated concentration of blood ketones without clinical disease
- More common than clinical ketosis
- Significant economic loss
- Common in high producing dairy cows – 2-7 weeks postpartum
- Small additional nutritional or metabolic insult – develop clinical ketosis

Thank you