Carbohydrates and Metabolism

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Carbohydrates

- Carbohydrates are substances consisting of C, H, O which contain alcohol, ketone and aldehyde functions.
- Except for the **lactose** in the milk, liver and cystic **glycogen**, all of the carbohydrates are vegetable origin.
- In the vegetative world, solar energy is synthesized by using CO2, H2O and photosynthesis together with O2.

Carbohydrates

- **In plants**, 70% (50-80) / DM
- Crude fiber in the cell wall material
- In grain, roots and tubers is starch and sugar .

- Carbohydrates are simple sugars and glycogen in the **animal's body**..

Carbohydrates

- It is a basic energy source.
- In the animal organism, glycogen is the **only reservoir** carbohydrate.
- In green plants, photosynthesis from water and carbon dioxide in the presence of sun rays and chlorophyll, formaldehyde, from which carbohydrates such as starch and cellulose are synthesized.

Classification of CHO

According to chemical structure;

1. Monosaccarides (including 1 mollecule)
2. Oligosaccarides (2-8 mollecules)
3. Polysaccarides (more than 8 mollecules of simple sugar)

According to simple sugar type;

a) Homopolysaccarides (including only one type simple sugar like starch and glycogen)

b) Heteropolysaccarides (Yincluding more then simple sugar like hemicellulose and pectin)

Classification of CHO

Again in terms of herbal world functions and **animal usability**, carbohydrates,

1. Structural carbohydrates (cellulose, hemicellulose, lignin, NDF, ADF)

2. Non-structural carbohydrates (starch and sugars)

Monosaccarides

- According to the number of C-atoms in the structure, the monosaccharides are named as biose, triose, tetroz, pentose and hexose.
- The most important monosaccharides in terms of nutrition are pentoses and hexoses.

Pentoses

- **Arabinose (Arabian gum):** Beetroot and sugar beet are placed.
- **Xylose (wood sugar):** It is found in the form of straw, hay, bran, oat flakes, xylen in corn cob.
- **Ribose:** It is involved in the structure of DNA, RNA, riboflavin and enzymes.

Heksoses

- **Glucose (Dextrose, grape sugar, blood sugar):**
- The most important simple sugar.
- In sweet fruit and honey; are free.
- Starch is involved in the formation of cellulose and glycogen.
- Carbohydrate is the most important end product of digestion. Glucose is released and absorbed as a result of starch digestion in single mussels and poultry.
- These animals are the main source of energy.

Heksoses

- **Fructose (Fruit sugar):**
- It is the sweetest simple sugar.
- Green leaves, fruit and honey are freely available. There is an important role in preventing the crystallization of honey.
- Sperm is the energy store.
- It forms sucrose together with glucose (sucrose = tea sugar).
- Inulin, which is formed by the combination of many fructose molecules, is found in the sweet potato.
- Because fructose is better assessed from glucose, it is important for diabetic diets.

Heksoses

- **Galactose:** It is involved in the structure of lactose, galactolipid, galacturonic acid, gum and mucins. It forms milk sugar (lactose) with glucose.
- **Mannose:** is found in various plants as mannan. It is a building block of some proteins (glucoprotein).

Disaccarides

- Two molecules of hexosaccharide form the result of conjugation by giving water.
- **Sucrose (sucrose):** glucose + fructose. It is found in sugar cane (20%) and in beets (15-20%).
- **Lactose (Milk sugar):** glucose + galactose. Cow milk was 4.6-4.8%; sheep milk 4%, goat milk 4.6%, female 7%, mare 5.87%.
- **Maltose:** formed from 2 moles of glucose (glucose + glucose). When barley is germinated, it is formed from starch by enzyme effect and is called malt sugar.
- **Cellobiose:** It is composed of 2 moles of glucose. It is released by the cellulosic destruction.
- **Trehalose:** It is found in mushroom and seaweed.

Polysaccarides-Homopolysaccarides

- It is a plant nutrient storage and structural material.

1. Glucans: A large number of glucose molecules come into being in various forms. ß-glucans.

a) Starch: It is the storage form of carbohydrates in plants. It consists of amylose and amylopectin. Amylose (20-28%) is in the inner part and amylopectin (72-80%) is in the outer part.

15-20% in patato

65-70% in grains

Polysaccarides-Homopolysaccarides

- In order to be able to use starch more effectively in the animal nutrition, some technological applications have changed their physical properties.

1) Dry methods (grinding and dry crushing): The grinding of starch rich feedstuffs reduces the particle size, increases the surface area and improves digestion.

2) Age Methods (extrusion and steamed corn): Extruding and starch digestion of starch rich feedstuffs (such as corn, barley, wheat, sorghum) increases gelatinization and starch digestion.

- **Gelatinization** is the transformation of the granule structure into amorphous form by treating starch with temperature and humidity.

Polysaccarides-Homopolysaccarides

b) Glycogen: is present in the animal body and in microorganisms. Its chemical structure is similar to amylopectin. It's the only carbohydrate that can be stored in animals. In animals, it plays an important role in the storage of the liver and muscle, and in a limited way, in meeting the animal's glucose and energy needs.

c) Cellulose: consists of ß-glycosidic linked glucose molecules. are degraded to cellobiose and glycosides with bcellulase enzymes of bacteria, fungi, germinated seed. In rumen and intestinal microorganisms it is degraded to VFA, methane, carbon dioxide and hydrogen.

Polysaccarides-Homopolysaccarides

2. Fructans: They consist of fructose molecules. It is found as a inulin in sweet potato, tapioca and meadow grass.

3. Galantone and Mannans: The plant is located on the cell wall.

Polysaccarides-Heteropolysaccarides

Pectin: It is found in more leguminous forages. In sugar beet 15-30% KM.

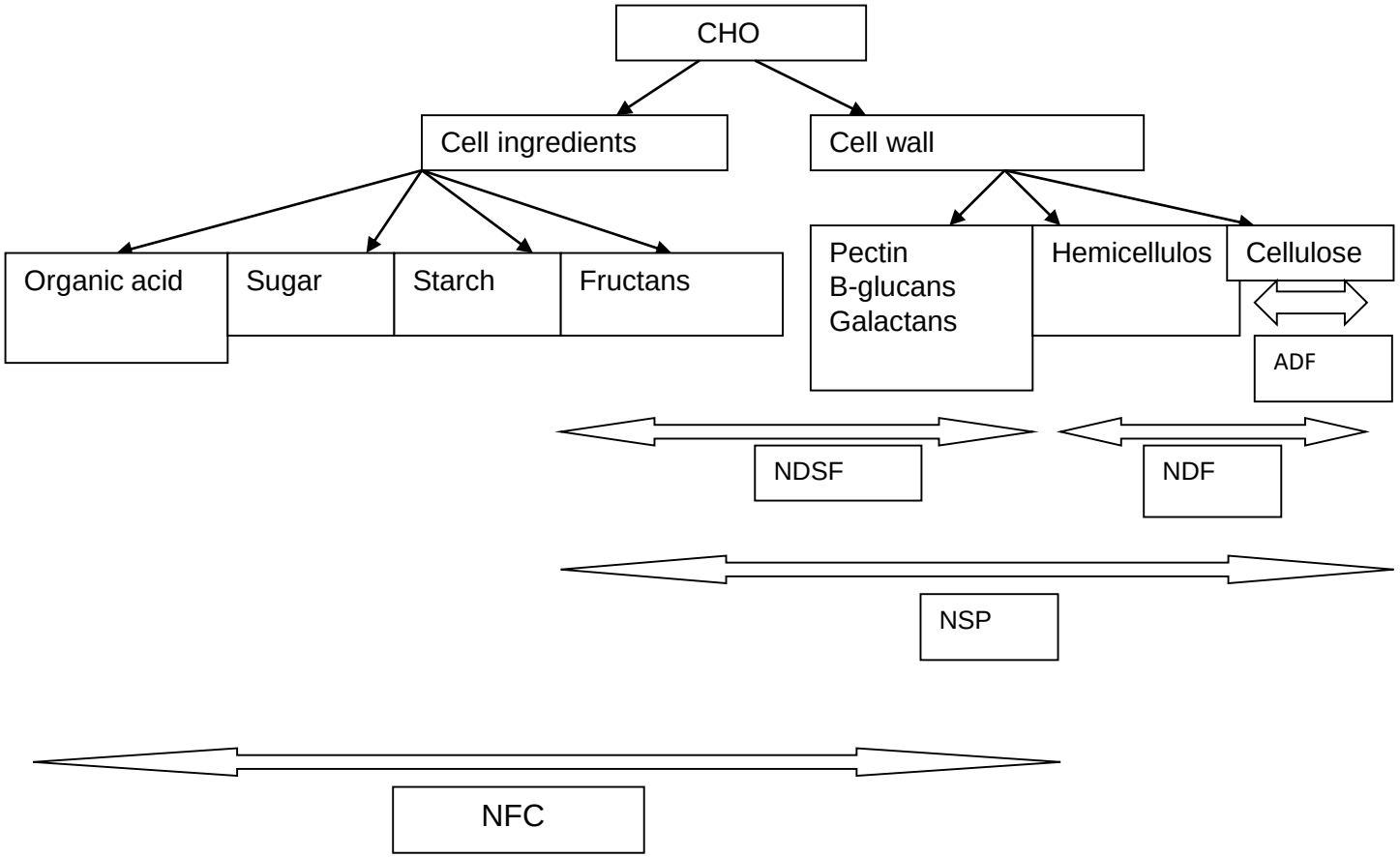
β-**glucans: I**n wheat germs they are found in very small amounts on cell walls. But barley and oat bran contain significant amounts of β-glucan. There are no enzymes to digest β-glucans in poultry and mammals.

Polysaccarides-Heteropolysaccarides

Hemicellulose: It is one of the cell wall elements. It is less resistant to degradation than cellulose. In ruminants, ruminal cellulose is heavily digested from hemi cellulose, but in significant amounts hemicellulose is fermented in the lower parts of the digestive tract, freeing from rumen fermentation. The reason for this is; that the cellulose-lignin layers surrounding the hemicelluloses in the feed material are leaving the rumen until the feed is digested in the rumen.

Polysaccarides-Heteropolysaccarides

Lignin: Lignin is not exactly a carbohydrate. Since the cell wall is detected together with the elements, the animal is considered under this group in feeding. Lignin enhances the stability of the plant cell by wrapping cellulose and hemicellulose. In the meantime, it also reduces the digestibility of cellulose and hemicelluloses. As the vegetation progresses, ligninisation increases and digestibility deteriorates. Lignin is not digested by both mammalian and microbial enzymes. Therefore, it can be used as an indicator in the indicator method used for digestibility of feeds. On the other hand, lignin is digested by some fungi and aerobic microorganisms.


CHO
Cell ingredients
Cell wall
Organic acid
Sugar
Starch
Fructans
Pectin
B-glucans
Galactans
Hemicellulos
Cellulose
ADF
NDSF
NDF
NSP
NFC

Digestive Metabolism of CHO

In Non-Ruminants:

- In non ruminants, digestion of carbohydrates begins with salivary amylase in the mouth, continues with pancreatic amylase in the small intestines, and is completed with disaccharidases in the intestines (maltase, sucrose and lactase (except for the poultry)).
- The most important source of energy for non-ruminant animals is starch.

Digestive Metabolism of CHO

Carbohydrates that absorbed from the intestines;

- ✓stored as glycogen in the liver and muscles
- ✓they are oxidized to produce energy
- ✓The excess carbohydrates are converted into fat and stored in fat tissue
- ✓are used in the biosynthesis of non-essential amino acids

Digestive Metabolism of CHO

- Fructose from fructose 6-phosphates,
- Galactose is converted to glucose 1-phosphatase and added to glycolysis and used for energy production in the Krebs cycle.

Digestive Metabolism of CHO

In Ruminants:

- There is no amylase in their saliva. It is degraded by amylase produced by microorganisms in the rumen.
- Carbohydrates that reach to the rumen;

a) cellulose is converted to glycoside,

b) Hemicellulose … xylose,

c) pectin is destroyed by galacturonic acid.

d) simple sugars … pyruvate,

e) pyruvate to acetate, propionate or butyrate.

Digestive Metabolism of CHO

Volatile Fatty Acids

Absorbed volatile fatty acids are transported through the portal vein to the liver.

Propionate is converted to glucosamine and glycogen by gluconeogenesis.

Acetate and butyrate are converted to acetyl Co (active acetic acid).

It either enters the cycle of crebs or is used for fatty acid synthesis.

Digestive Metabolism of CHO

What are the sources of the blood glucose?

Digestive Metabolism of CHO

1. Glucose absorbed from gut
2. Glycogenolysis (breakdown of glycogen)
3. Gluconeogenesis (Glucose synthesis from sources other than carbohydrates)

Digestive Metabolism of CHO

What are sources other than carbohydrates used in the synthesis of glucose?

Digestive Metabolism of CHO

1. Amino acids
2. Lactic acid
3. Propionic acid
4. Glycerol