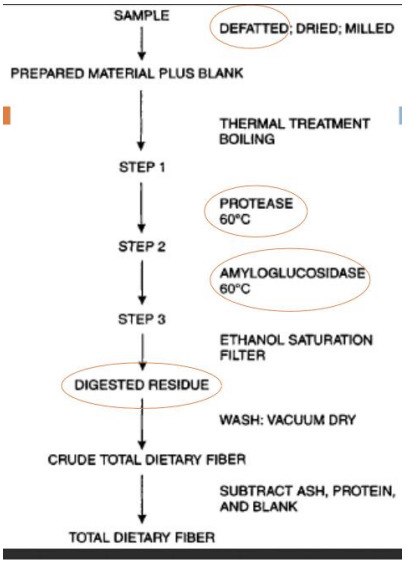
Dietary Fibres

The fraction of edible parts of plants or analogous carbohydrates that are:

- Resistant to digestion and absorption in the human small intestine with..
- Complete or partial fermentation in the large intestine



Regulation Authorities

1. FSANZ
   - Food regulation, safety standard, analysis standard and labelling
2. Association of the Official Analytical Chemist, USA (AOAC)
   - Definition and analysis of dietary fibres.
   - Methods and protocols.
   - Recognised for labelling food products.

Total Dietary Fibres

- Residue of plant materials remaining after the removal of
  - Lipids by solvent extraction
  - Proteins by protease digestion
  - Starch by amyloglucosidase digestion

FIBRE CLASSIFICATIONS

Soluble Fibres: can be..	*Viscous -large molecules*	*Non-Viscous – too small*
• B-Glucans	B-Glucans	Galacto-Oligosaccharides
• Gums	Gums	Fructans
• Galacto-oligosaccharides (GO)	Pectins	
• Fructans	Hemicelluloses	
• Some pectins		
• Some hemicelluloses		

Fermentable	**Insoluble Fibres: can be..**	*Non-Fermentable*
• GO- produce gas in short time	Cellulose	Cellulose
• Fructans	Most hemicelluloses.	Most hemicelluloses
• B-Glucans	Some pectins	
• Gums		
• Pectins		
• Some hemicelluloses		
• Alginates		
• Carrageenans		

Prebiotics

- Are a selectively fermentable ingredient that a) stimulates growth b) increases activity and c) changes the composition (SIC) of gastrointestinal microflora, contributing to improving host health.
- All prebiotics are fibre however as mentioned in the classifications. Not all fibres are prebiotic.

Bacteria fermentation

- Colonic bacteria use a range of carbohydrate hydrolysing enzymes to breakdown starch and dietary fibres into absorbable monosaccharides.
- Hydrolyzed material is then taken up by bacteria and undergoes metabolism to generate energy for bacteria growth.

Gut Microflora

- The human GIT is one of the most diversely colonized (<1000) and metabolically active organs in the human body.
- Beneficial bacteria > 90% of the total population and include *Bifidobacteria, Lactobacilli* and *Escherichia coli* having an almost exclusive saccharolytic metabolism (breakdown sugars in metabolism with the production of energy)
- Harmful bacteria including *Streptococcus* and *Clostridia* have an almost proteolytic metabolism (protein degradation, is energy dependent)

Roles of Intestinal Flora

- Contributes significantly to the barrier that prevents pathogenic bacteria from invading the GIT
- Ferments undigested carbohydrates in lower GIT, salvaging energy to use metabolically for the host.
- Contribute to stool bulking
    - Dietary components that stimulate fermentation lead to an increase in bacterial mass that consequently contributes to fecal mass.
    - 30g of bacteria per 100g of fermented Carbohydrates.

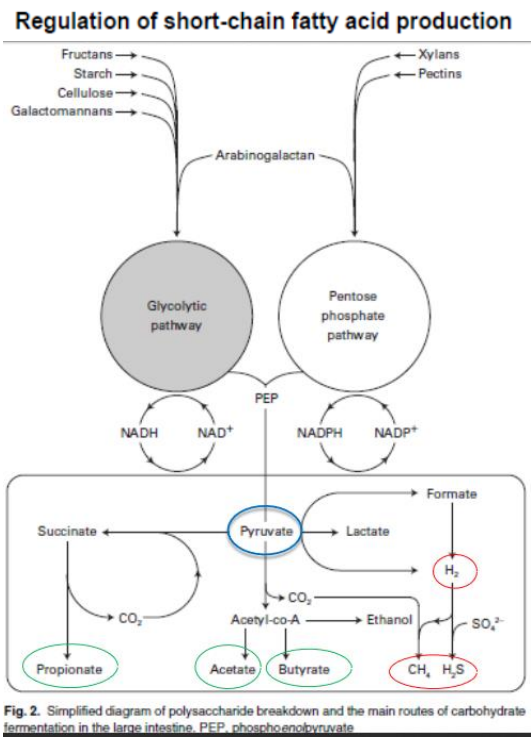


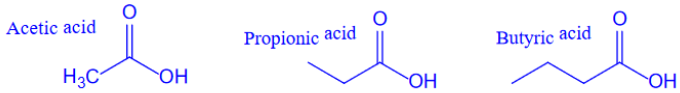
Fig. 2. Simplified diagram of polysaccharide breakdown and the main routes of carbohydrate fermentation in the large intestine. PEP, phosphoenolpyruvate

Factors that influence microflora composition

- Composition of the diet – presence of dietary fibres
- Changes in physiological conditions of the host: Health (H), Age (A), Stress (S) – HAS
- Environmental circumstances: antibiotic therapy, hygiene with antiseptics, environmental pollution.

Short Chain Fatty Acids (SCFAs)

- Short chain carboxylic acids. Acidic in intestinal pH (6.8-7.4) due to ionisation (+/- ion) of COOH- function



- They are highly water-soluble, readily absorbed from the colon into the blood

SCFAs are an energy source

- Colonocytes (epithelial cell of colon)
    - Butyrate is considered a key nutrient determining the metabolic activity and growth of colonocytes. Is it used preferentially over glucose as an energy source.
- Host
    - Further metabolism of SCFAs in the liver, muscle and other peripheral tissues contributes 7-8% of daily energy requirements of the body.

SCFAs and colon health

- Inhibits the growth of pathogenic organisms by reducing luminal and fecal pH
- Reduces peptide degradation and the resultant formation of toxic compounds ammonia and amines.
- Decreases activity of undesirable bacterial enzymes.

Different fibres vary in the amount and ratio of SCFA produced, as well as the ratio of production

- Fermentation pattern is related to the MW, chain length and structure of the fibre
- Short chain highly soluble molecules, such as fructose OS (fructans) and galactose OS, are fermented much more rapidly than larger, longer chain molecules such as gums, pectins and b-glucan.
- Fermentation of hemicelluloses is largely determined by the side chain sugars that affects solubility and variety of glycosidic bond
- Cellulose is largely not fermentable because of high degree of crystallinity that render the polymer totally insoluble.
- Fibres that are fermented quickly may lead to excessive gas production and bloating, so regular but low dose intake is an important consideration

Research and Study

1. Human data are only helpful in inferring health outcomes of dietary fibres
   Accepted protocols of feeding fibre/OS to healthy humans and measure microbiota do not exist. Faecal samples are not typically collected in studies, scarce information
2. Epidemiological studies provide important causal links for diet-disease relationships.
3. Intervention studies in target populations provide direct evidence of efficacy

Beneficial Health Effects of Fibres

1. Prevents Constipations
   - Constipation is associated with insufficient or hardened faeces. Stimulation of colon to induce contraction is necessary for stool elimination.

STIMULATES BOWL MOVEMENT BY..

- Insoluble fibres: Providing bulk for stools.
- Water soluble and poorly fermentable fibres: providing bulk and softening stools. (Water constitutes 75%)
- Water soluble and highly fermentable fibres: due to gas production

2a. Provides satiation – feeling of fullness during consumption, leading to meal termination

- Related to providing bulk in the stomach inducing satiation
- Both insoluble and soluble fibres are effective
- Gram by gram soluble fibres are more effective as it retains water therefore greater overall bulk.

2b. Provides satiety – feeling of fullness from a previous meal

- Several gut hormones can identify signals of satiety and promote hunger

ENHANCED: glucagon like peptide (GLP-I) and peptide tyrosine tyrosine (PYY), both produced by the L-cells of the ileum and proximal colon. (specialised cells with endocrine function)
PROMOTING HUNGER: Ghrelin suppreses secretion of GLP-I and PYY, as well as leptin (a hormone produced by adipose cells that help energy balance by inhibiting hunger)

- Fermentability and viscosity of DF interact to influence satiety and adiposity-related plasma hormone.
  - Highly viscous and poorly fermentable are the most effective

3. Provide control release of nutrients

- Relating to trapping nutrients (vitamins) and non-nutrients (polyphenols) by fibres in food matrix that control their release
- Control release enhances absorption in small intestine as it is not limited by saturation of absorption sites.
- Soluble viscous gel forming fibres effective ie. pectins, B-glucan

4. As prebiotics
- Related to fermentability of carbohydrates by bacteria
- Most soluble fibres and some poorly soluble fibres.

5. Reduces cholesterol absorption
- Ability to trap cholesterol
- Poorly fermentable gel forming soluble fibres are effective

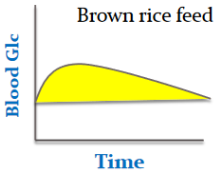
6. Reduce fat digestion/absorption
- Ability to trap fats or bile
- High methoxyl pectin ability to trap fats due to its hydrophobic surfaces
- Chitosan interacts with FFA preventing their absorption

CASE STUDY- B-GLUCAN LOWERING CHOLESTEROL ABSORPTION FROM FOODS
B-Glucan is a soluble, viscous, fermentable fibre.

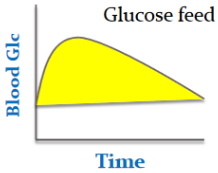
- Physical effect due to formation of a viscous gel.
    - Reducing intestinal absorption of cholesterol by physical entrapment
    - Binds bile acids and increases their excretion within faeces, therefore less to liver
        - Production of more bile acids from cholesterol of endogenous origin reducing circulating blood cholesterol.
    - Increase gastric emptying? – UNKNOWN.

QUESTION: why do B-glucan have a greater effect than barley B-glucan?

Glycaemic Control and Type 2 Diabetes.
- Glycaemic Index (GI) is a measure of a carbohydrates post-prandial glucose response.
- The lower the GI value, the slower the rise in blood glucose levels when the food is consumed.
    - LOW GI: reduce post-prandial glucose levels, reduce plasma insulin levels and improve insulin response.

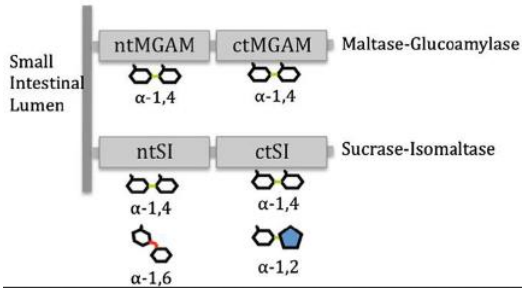


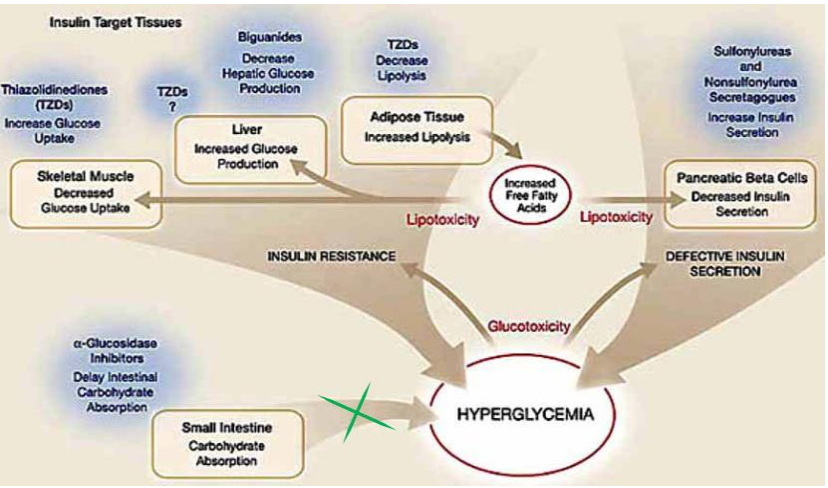
Glycaemic Index = food (area under curve)/ glucose (area under the curve)
- Feeds 10+ healthy people a food consuming 50g carbohydrates, measure blood glucose levels over the next 2 hours, repeat feeding with 50g glucose.
- Glc (100), Suc (60), Wheat bran (28)

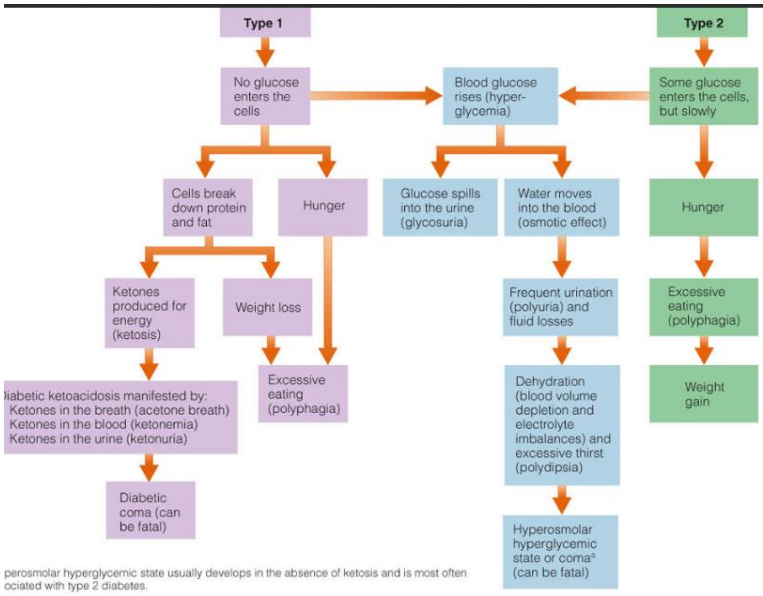


Pancreating a-amylase
- A calcium metallic endoenzyme that catalyse the hydrolysis of internal a-1,4- glucosidic bonds in amylose and amylopectin.

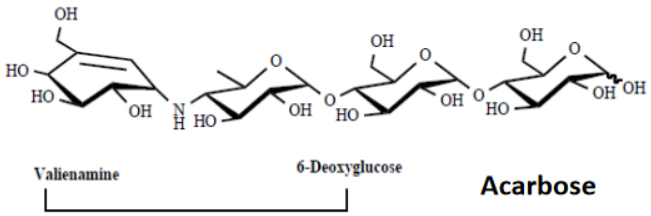
Intestinal a-glucosidase
- Sucrase-Isomaltase complex
    - Breaks down sucrose, maltose and isomaltose to fructose and glucose.
    - The majority of maltase activity is contributed by the sucrose-isomaltase complex due to its higher relative abundance.
- Maltase-glucoamylase complex
    - Dimers are short, linear oligomers such as maltose, maltotriose and maltotetrose are preferentially hydrolysed into glucose.







- Persistent postprandial hyperglycaemia is an early defect (impaired glucose tolerance) of Type 2 diabetes and one of the primary anti-diabetic target.
- The blood glucose curve can be flattened if the release of glucose from starch is delayed.
    - Restricting access to a-amylase (physical)
    - Inhibiting amylase (biochemical)
    - Inhibiting a-glucosidases (biochemical)



a-Glucosidase inhibitors

- Management of postprandial hyperglycemia
- Acarbose is a pseudo-tetrasaccharide with a nitrogen bond between the first and second glucose units
- Prescribed drugs and can't be added to foods or be used as supplements in glycaemic control.

Consuming soluble viscous fibres has the potential to.

- Attenuate glucose absorption rate by delaying starch digestion
- Prevent weight gain by promoting satiation and satiety
- Increase the absorption of beneficial nutrients and antioxidants in the diet by control release.
- All of which may help prevent metabolic diseases such as diabetes.