

Human Nutrition (DTC – 211)

EVALUATION OF NUTRITIVE VALUE OF FOOD

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Nutritive value

- indication of contribution of a food to the **nutrient content** of diet.
- value depends on
 - ❖ **quantity** of a food which is digested and absorbed and
 - ❖ **amounts** of the essential nutrients (pro, fat, carb, min, vit) which it contains.
- value can be affected by
 - **soil and growing conditions,**
 - **handling and storage, and**
 - **processing.**

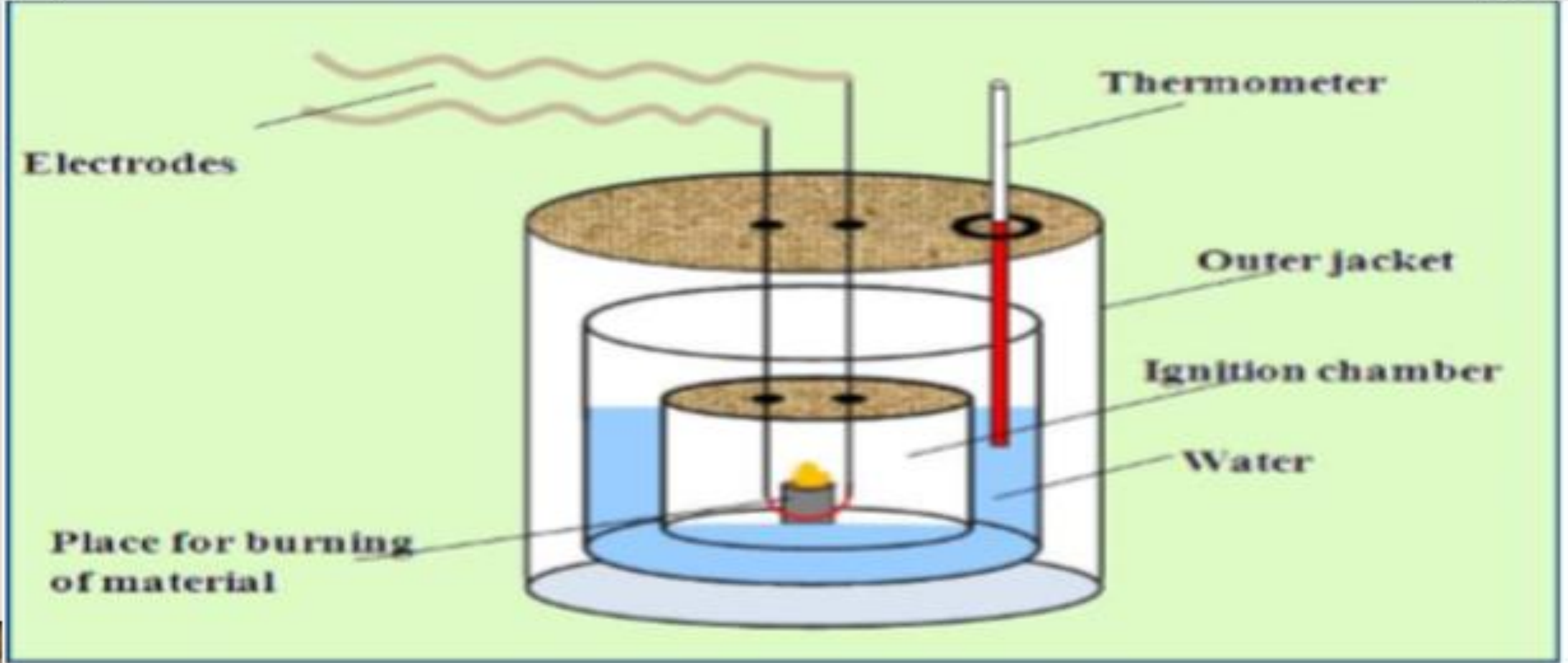
- Calorie Content
- **Bomb Calorimeter**
- a type of **constant-volume calorimeter** → measuring the **heat of combustion** of a **particular reaction**.
- have to withstand the large pressure within the calorimeter as reaction is being measured.

Unit—Kilocalorie (kcal)

amount of energy in the form of heat is required to raise the temp. of 1.0 Kg of water by 1.0 from **15 to 16°C**.

Basically, a **bomb calorimeter** consists of:

- a small cup to contain the sample,
- oxygen,
- a stainless steel bomb,
- water,
- a stirrer,
- a thermometer,
- the dewar and
- ignition circuit connected to the bomb



Electrical energy is used to ignite the fuel → it will heat up the surrounding air, which expands and escapes through a tube that leads the air out of the calorimeter. When air is escaping through copper tube it will also heat up the water outside the tube → temperature of water allows for calculating calorie content of the fuel.

Bomb Calorimeter

- Crude Protein

- *Kjeldahl* method and *Dumas* method

- determine **total nitrogen** in a sample

- only major component of most food → contains nitrogen → protein

- *fat, carbohydrate and dietary fibre do not contain nitrogen*

- total protein = amount of **nitrogen multiplied by a factor** (depending on the kinds of protein expected in the food) → known as "*crude protein*"

- On food labels → protein is given by **nitrogen X 6.25** (average **nitrogen content of proteins** is about **16%**)

Kjeldahl test → method the AOAC International has adopted and is therefore used by many food standards agencies around the world. The method consists of :

1. **digestion** of the substance *with **sulfuric acid*** in presence of ***potassium sulphate*** (increases the boiling point of the medium from 337°F to 373°F / 169°C to 189°C).

- Digestion **decomposes** the organic substance by oxidation to liberate the reduced nitrogen as **ammonium sulfate**.
- Chemical decomposition of the sample is complete when the **medium has become clear and colorless** (initially very dark).



2. solution is then distilled with *sodium hydroxide* (small quantities) which **converts** the ammonium salt \rightarrow **ammonia**

➤ amount of **ammonia** (amount of **nitrogen** present in the sample) is **determined by**

3. back titration \rightarrow end of the condenser is dipped into a solution of standard *boric acid* solution

➤ ammonia reacts with the acid and the **remainder of the acid** is then **titrated with a standard sodium carbonate** solution with a **methyl orange** pH indicator.



Nowadays, the Kjeldahl method is largely automated and makes use of specific catalysts (mercury oxide or copper sulfate) to speed up the decomposition.

•Carbohydrate

1. calculating the percent remaining after all the other components have been measured:

$$\% \text{ carbohydrates} = 100 - (\% \text{ moisture} + \% \text{ protein} + \% \text{ lipid} + \% \text{ mineral}).$$

- ❖ this method can lead to **erroneous results** due to experimental errors in any of the other methods, and so
- ❖ it is usually **better to directly measure** the carbohydrate content for accurate measurements.



- preparation of a sample for carbohydrate analysis depends on the **nature of the food** being analyzed.
- **Aqueous solutions**, such as fruit juices, syrups and honey, usually require **very little preparation** prior to analysis.
- many foods contain carbohydrates that are **physically associated or chemically bound to other components**, e.g., seeds, nuts, cereals, fruit, woody material breads and vegetables.
- it is usually necessary to **isolate** the carbohydrate from rest of the food before it can be analyzed.

- **Precise method** of carbohydrate isolation depends on
 - ❖ carbohydrate type,
 - ❖ food matrix type and
 - ❖ purpose of analysis

- however, there are some procedures that are common to many isolation techniques.

- Foods are usually
 - ❖ **dried** under vacuum (to prevent thermal degradation),
 - ❖ **ground** to a fine powder (to enhance solvent extraction) and then
 - ❖ **defatted** by solvent extraction.

- most commonly used methods of extracting *low molecular weight carbohydrates* is to **boil** a defatted sample with an **80% alcohol solution**.
- **Monosaccharides and oligosaccharides** are **soluble** in alcoholic solutions
- **proteins, polysaccharides and dietary fiber** are **insoluble**
- soluble components can be **separated** from the insoluble components by **filtering** the boiled solution and collecting the filtrate and the retentate
- These two fractions can then be **dried and weighed** to determine their concentrations



- In addition, to monosaccharides and oligosaccharides various other small molecules may also be present in the alcoholic extract that could **interfere with the subsequent analysis** e.g., **amino acids, organic acids, pigments, vitamins, minerals etc.**
- usually necessary to remove these components prior to carrying out a carbohydrate analysis.
- commonly achieved by **treating the solution with clarifying agents** or by **passing it through one or more ion-exchange resins.**



- number of chemical methods used to determine monosaccharides and oligosaccharides are based on the fact that many of these substances are **reducing agents** that can react with other components to yield precipitates or colored complexes which can be quantified.
- concentration of carbohydrate can be determined
 - ❖ **gravimetrically**,
 - ❖ **spectrophotometrically** or
 - ❖ **titration**.
- **Non-reducing** carbohydrates can be determined using the **same methods** if they are first **hydrolyzed** to make them reducing.
- It is possible to determine the concentration of both **non-reducing and reducing sugars** by carrying out an analysis for reducing sugars before and after hydrolysis.

- Many different chemical methods are available for quantifying carbohydrates.
- Most of these can be divided into three categories:
 - ❖ **titration,**
 - ❖ **gravimetric and**
 - ❖ **colorimetric**



❖ Colorimetric Methods

1. **Anthrone** method (**concentration of total sugars**).

- **sample + sulfuric acid + anthrone reagent** → **boiled** until the reaction is completed (yield a **blue-green color**) → **cool** and its **absorbance is measured at 620 nm**
- a linear relationship between the **absorbance and the amount of sugar** present in the original sample.
- determines **both reducing and non-reducing sugars** because of presence of the strongly oxidizing sulfuric acid.
- it is non-stoichiometric and therefore it is necessary to prepare a **calibration curve** using a series of standards of known carbohydrate concentration.

2. Phenol - Sulfuric Acid method

- clear aqueous solution of carbohydrates is placed in a test-tube, then phenol and sulfuric acid are added → yellow orange color as a result of interaction between the carbohydrates and phenol → absorbance at 420 nm is proportional to the carbohydrate concentration initially in the sample.
- sulfuric acid causes all nonreducing sugars to be converted to reducing sugars → this method determines the total sugars present.
- it is necessary to prepare a calibration curve using a series of standards of known carbohydrate concentration.
- ❖ Gravimetric Method
- ❖ Crude Fiber Method

- **crude fiber method** gives an **estimate of indigestible fiber** in foods → determined by sequential extraction of a **defatted sample** with **1.25% H₂SO₄** and **1.25% NaOH** → insoluble residue is collected by filtration → dried → weighed → ashed (to correct for mineral contamination of the fiber residue)
- **Crude fiber** measures **cellulose** and **lignin** in the sample, but **does not determine hemicelluloses, pectins and hydrocolloids**, because they are **digested by the alkali and acid** and are therefore **not collected**
- it is a fairly simple method to carry out and is the official AOAC method for a number of different foodstuffs.

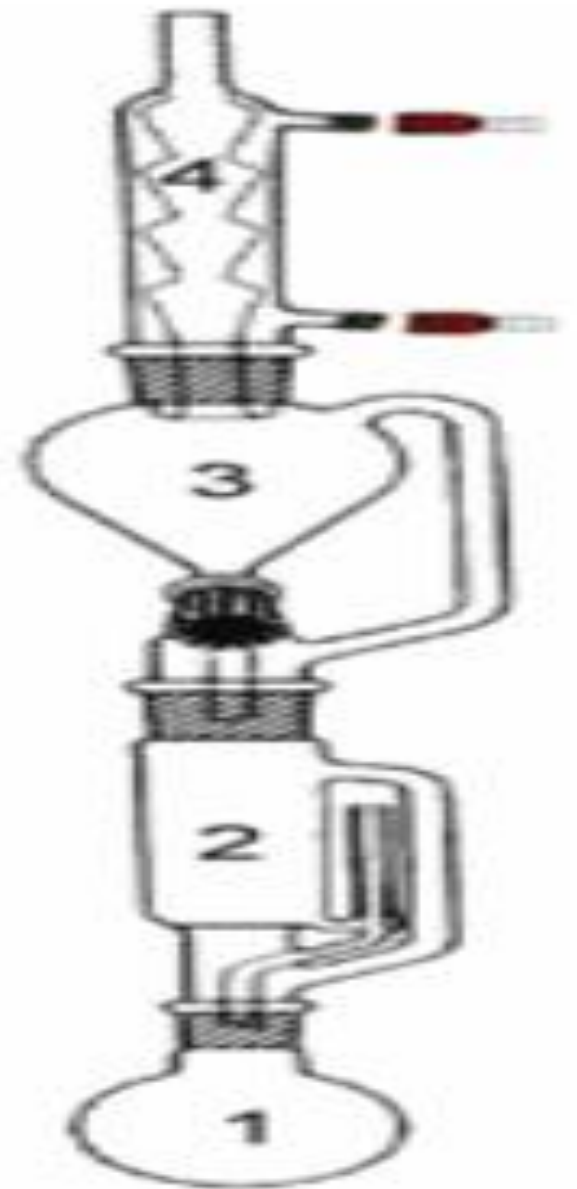


- **Lipid**

- **Soxhlet** (1879) → most commonly used example of a **semi-continuous method** applied to extraction of lipids from foods.
- Soxhlet's procedure → **oil and fat from solid material are extracted by repeated washing (percolation) with an organic solvent, usually hexane or petroleum ether, under reflux in a special glassware**
- **sample is dried, ground and placed in a porous cellulose thimble.**

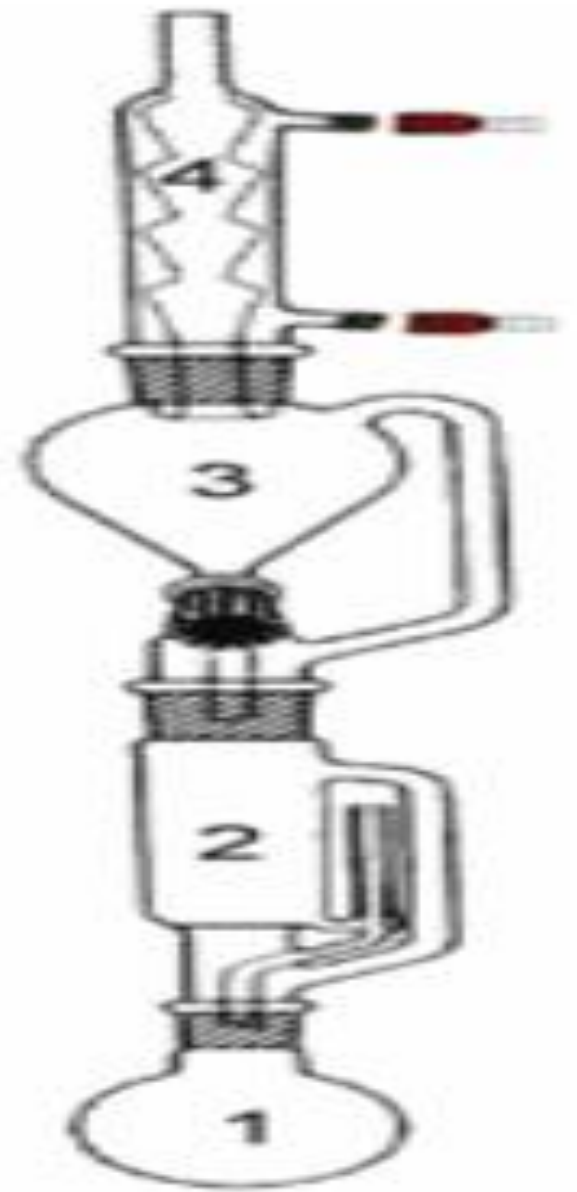


- thimble is placed in an **extraction chamber** (2), which is suspended above a flask containing the solvent (1) and below a condenser (4).
- flask is heated and the solvent evaporates and moves up into the condenser where it is converted into a liquid that trickles into the **extraction chamber** containing the sample.
- extraction chamber is designed so that when the solvent surrounding the sample exceeds a certain level it overflows and trickles back down into the boiling flask.



SOXHLET APPARATUS

- At the end of the extraction process (few hours) flask containing the solvent and lipid is removed.
- In some device a funnel (3) allows to recover the solvent at the end of the extraction after closing a stopcock between the funnel and the extraction chamber.
- The solvent in the flask (1) is then **evaporated** and the **mass** of the **remaining lipid** is measured.
- The percentage of lipid in the initial sample can then be calculated.



SOXHLET APPARATUS

- Despite disadvantages of this procedure (poor extraction of polar lipids, long time involved, large volumes of solvents, hazards of boiling solvents) several methods involving automatic solvent extraction were described.
- Different **automated** or **semi-automated extraction instruments** may be found in the market.



Nutrition Value of Milk

- **perfect food** as it **provides vital nutrients** like proteins, EFA, vitamins, minerals and lactose **in balanced proportions**.
- It **complements and supplements nutrients** available from grains, legumes, vegetables, fruits, meat, seafoods and poultry.
- Milk has **high nutrient density**.
- High concentration of major nutrients at relatively **low caloric** value.



Nutrition value of Cow, buffalo and goat milk per 100g

	Cow	Buffalo	Human
Water	87.99	83.39	87.50
Food energy (Kcal)	61.44	96.62	69.56
Protein (g)	3.29	3.75	1.03
Fat (g)	3.34	6.89	4.38
Carbohydrate (g)	4.66	5.18	6.89
Ash (g)	0.72	0.79	0.20
Ca ²⁺	119.4	169.0	32.2

Milk Fat

- ❖ The Good and the Bad
- cholesterol level in milk is low, milk fat is considered **hypercholesterolemic**.
- mainly because of its **high-saturated fatty acid content (60 to 65%)**.
- Palmitic (C16:0) and Myristic(C14:0) acids have been shown to be **hypercholesterolemic**
- shorter fatty acids (C4-C10) are **neutral**.
- Stearic, C18:1 and C18:2 acids are **hypocholesterolemic**.

- ❖ Bovine milk fat contains
- ❖ significant amounts of short chain fatty acids and lower concentrations of C18 fatty acids than beef or pork.
- ❖ also a **poor source of polyunsaturated fatty acids.**
- ❖ Milk fatty acids are derived in part from **dietary long chain fatty acids**, **microbial synthesis of fatty acids** and **body stores of fat** with remainder coming from **de novo synthesis** in the mammary glands.
- ❖ **Manipulating the diet** of dairy cow can substantially **alter balance** between mammary de novo synthesis of short and medium chain fatty acids, and dietary long chain fatty acids presented to the mammary gland.



Biological Importance of Milk Proteins

- ❖ Main **source of amino acids** for newborn
- ❖ Casein micelles also provide **Ca and P** for skeletal development
- ❖ **highly digestible** by proteolytic enzymes of **newborn**
- ❖ Some milk proteins have intracellular functions → **Beta-lactalbumin** forms a part of the enzyme **lactose synthase**

- Milk contains proteins such as **lactoferrin** and **lysozyme**
- **antibacterial properties of these materials,**
- ❖ **lysozyme** digesting bacterial polysaccharides and
- ❖ **lactoferrin** sequestering iron required by bacteria
- emphasize their **importance in reducing mastitis infections**

- Lactoferrin concentration is high in the dry bovine mammary gland

- In many mammalian species including bovine **colostrum** is a **vital way of transferring passive immunity** from mother to the newborn



THANKS