



Fat Analysis & Equipment used

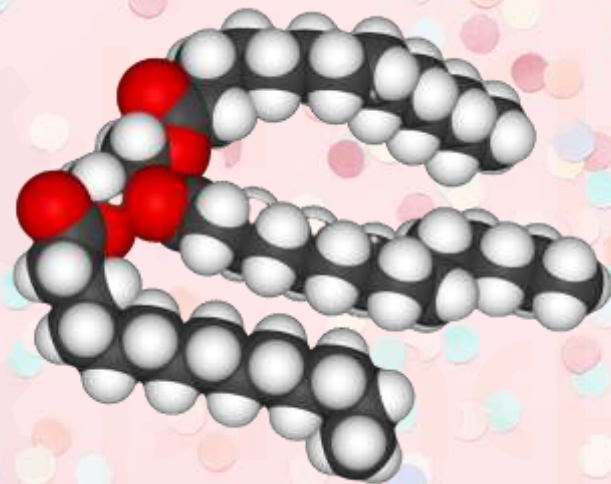
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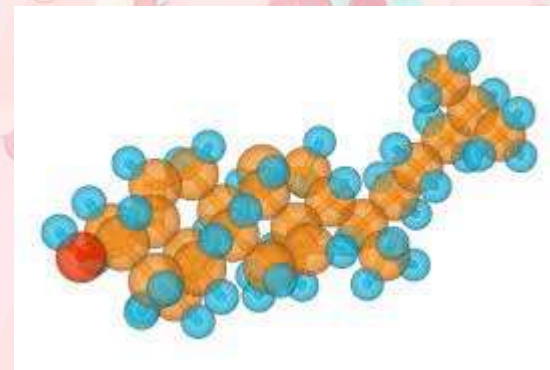


1. What is fat?

- Fats are primarily the triesters of fatty acids and glycerol and thus are commonly called triglycerides.
- Solid triglycerides are referred to as fat while liquid triglycerides are called oils.
- Lipids, on the other hand, include all the 'fatty' materials—the substances dissolved in a fat-solubilizing solvent in a food.



Fat



Lipid

2. Fat Analyzing Methods

- Many techniques have been created over the years for analyzing the fats in various food products.
- These techniques are based on how straightforward it is to remove fat from a particular matrix.
- Also, the choice of technique depends on whether total lipids or fat are to be extracted from the sample.



Equipment used for fat determination

3. Fat Testing Procedure

Techniques

Types of food products

3.1. Gas Chromatography

Any type of Fat

3.2. Gravimetric Procedure

Dairy Fat

3.2.1 Acid hydrolysis

3.2.2 Base hydrolysis

3.2.3 Acid & Base hydrolysis

3.3 . Chemical Methods

Dairy Fat

3.3.1 Geber method

3.3.2 Babcock Test

3.4 Hydrometer

Dairy Fat

3.5 DEXA (Dual Energy X-Ray Absorption)

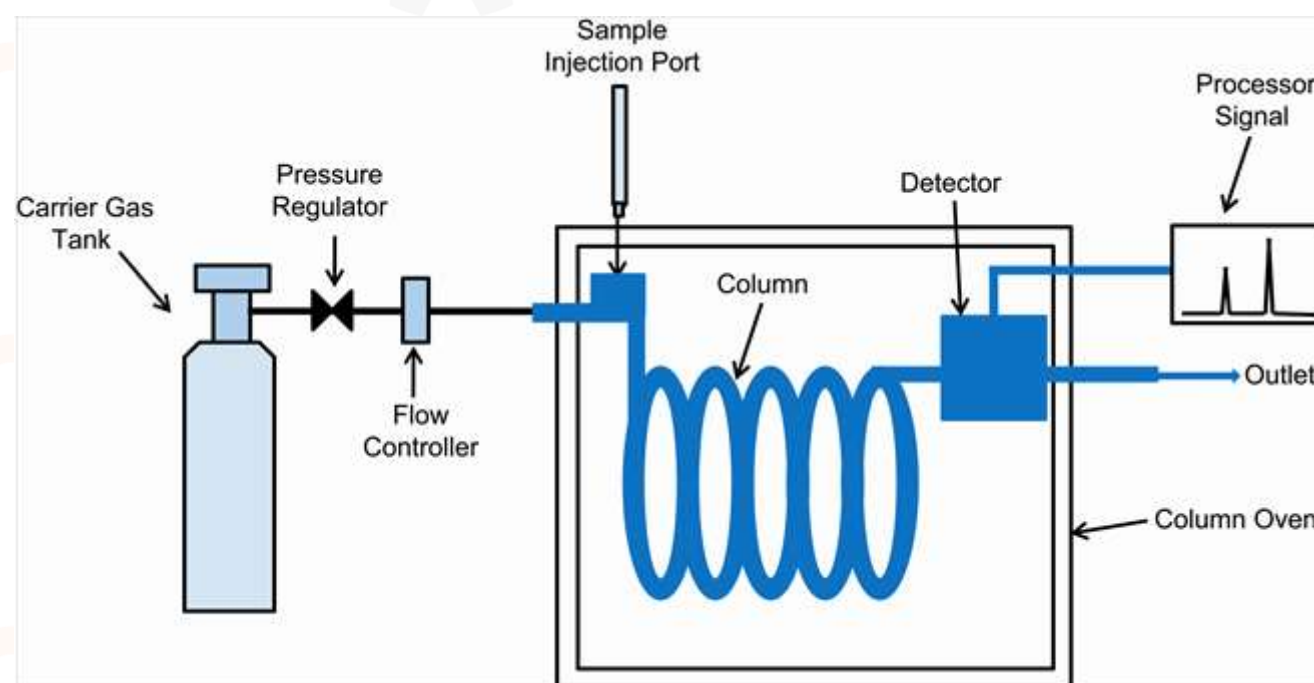
Meat Fat

3.6 NMR Technology (Nuclear Magnetic Resonance Technology)

Any type of Fat

3.1. Gas Chromatography

- Gas chromatography (GC) is a common type of chromatography used in analytical chemistry for separating and analyzing compounds that can be vaporized without decomposition.



Working Principle

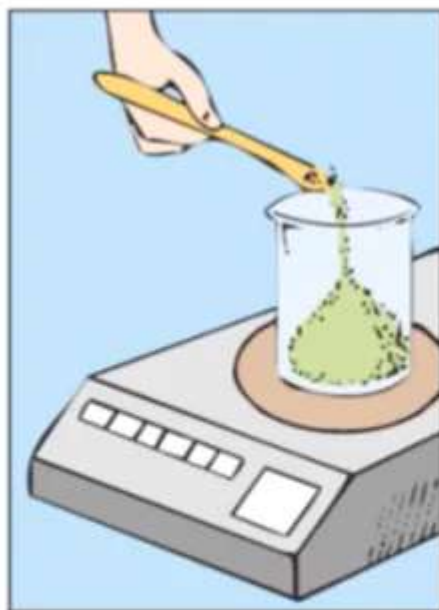
A gas chromatograph is made of a narrow tube, known as the column, through which the vaporized sample passes, carried along by a continuous flow of inert or nonreactive gas.

Components of the sample pass through the column at different rates, depending on their chemical and physical properties and the resulting interactions with the column lining or filling, called the stationary phase.

The column is typically enclosed within a temperature-controlled oven. As the chemicals exit the end of the column, they are detected and identified electronically.

3.2. Gravimetric Procedure

- Gravimetric analysis describes a set of methods used in analytical chemistry for the quantitative determination of an analyte (the ion being analyzed) based on its mass.



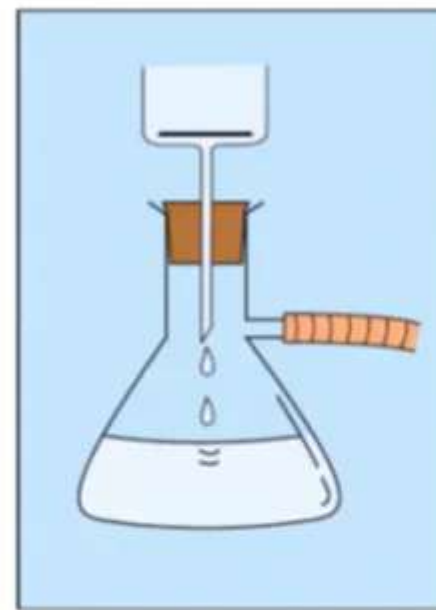
(a) Weighing the sample to be analysed



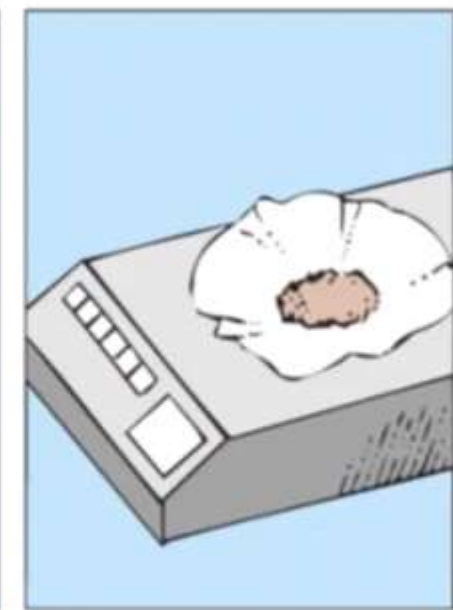
(b) Dissolving this sample in water



(c) Adding a suitable chemical to form a precipitate



(d) Filtering to collect the precipitate



(e) Repeated drying and weighing until a constant mass of precipitate is obtained

Working Principle

- The principle of this type of analysis is that once an ion's mass has been determined as a unique compound, that known measurement can then be used to determine the same analyte's mass in a mixture if the relative quantities of the other constituents are known.

Types of Gravimetric Procedures

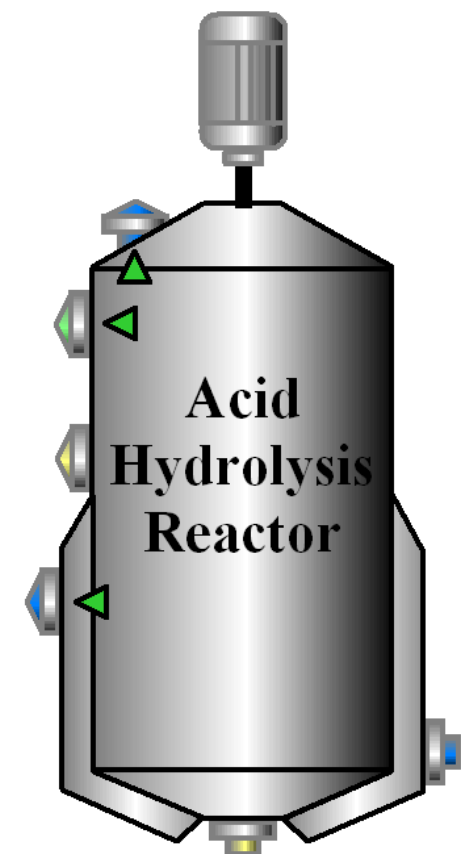
3.2.1 Acid Hydrolysis

3.2.2 Base Hydrolysis

3.2.3 Acid & Base Hydrolysis

3.2.1. Acid Hydrolysis

- The acid-hydrolysis method extracts fat from the sample by subjecting it to hydrochloric acid and mixed ethers.
- Food samples tested and analyzed using the acid-hydrolysis procedure are baked products, bread, cereal, cooked products, eggs, fish, flour, food dressings, fruit, grain, mixes, pasta, and products with cocoa, seafood, and vegetables.



Acid Hydrolysis Procedure

Step 1

- The hydrochloric acid breaks fatty acids from the glycerides, glycolipids, phospholipids, and sterol esters

Step 2

- Acid hydrolysis also breaks lipid-carbohydrate bonds, assists in the hydrolyzing of proteins and polysaccharides, and disrupts cell walls

Step 3

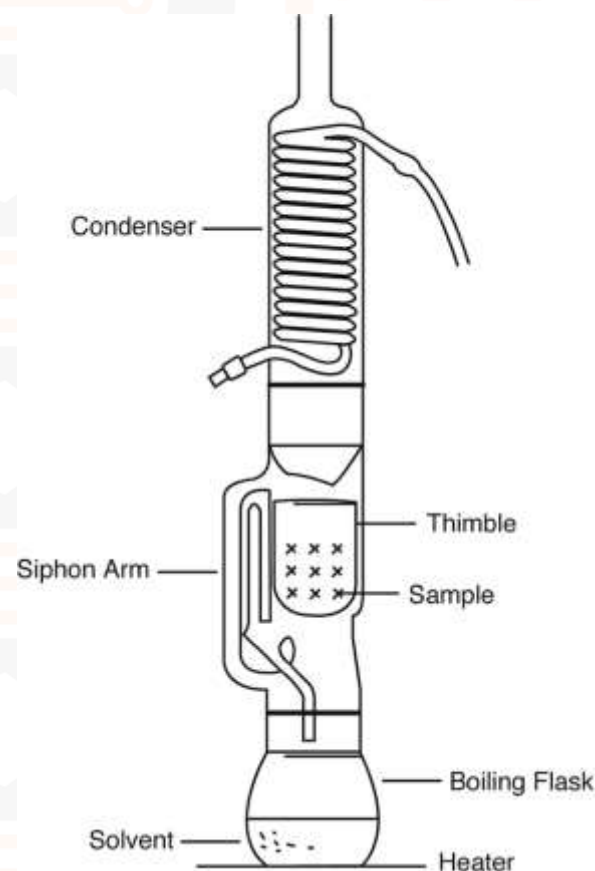
- All of this makes the lipids available for complete extraction with mixed ethers

Step 4

- The ether is evaporated, and the extracted residue is weighed

3.2.2 Base Hydrolysis

- The base-hydrolysis method, typically used for dairy matrices (Roesse-Gottlieb), extracts fat from the sample by treating it with ammonium hydroxide and subjecting it to mixed ethers.
- Food samples tested and analyzed using the base hydrolysis procedure are dairy products such as cream cheese, milk, non-fat dry milk, yoghurt, and whey.



Roesse-Gottlieb setup

Base Hydrolysis Procedure

Step 1

- The ammonium hydroxide weakens lipid-protein bonds in order to disrupt the casein, breaks up fat emulsions, and neutralizes any endogenous acid prior to the extraction with mixed ethers

Step 2

- A centrifugation step also aids in the breaking of emulsions, which are common in dairy products, and it aids in separating the ether layer from the aqueous phase

Step 3

- Samples are extracted into mixed ethers

Step 4

- Total fat is calculated gravimetrically after evaporation and residue weighing

3.2.3 Acid & Base Hydrolysis

- This method is, sometimes necessary for matrices where the fat is difficult to remove,
- Done using extracts fat from the sample by treatment with ammonium hydroxide.
- The fat is then subjected to a hydrochloric acid solution and extracted using mixed ethers.
- Food samples tested and analyzed using the acid and base hydrolysis procedure are cheese, cheese blends, entrees with cheese, products with cheese, pizza-roll filling, and pizza.



Hydrolysis Unit

Acid & Base Hydrolysis Procedure

Step 1

- The ammonium hydroxide weakens the lipid-protein bonds

Step 2

- The acid breaks the lipid-carbohydrate bonds making the lipid available for complete extraction

Step 3

- Samples are extracted into mixed ethers

Step 4

- Total fat is calculated gravimetrically

3.3. Chemical Methods

3.3.1. Geber method - the Gerber method is a primary and historic chemical test to determine the fat content of substances, most commonly milk and cream.

3.3.2. Babcock Test - the Babcock test is an inexpensive and practical procedure to determine the fat content of milk.



Gerber Centrifuge



Hand centrifuge for the Babcock test

3.3.1 Gerber method procedure

Milk fat is separated from proteins by adding sulfuric acid.

The separation is facilitated by using amyl alcohol and centrifugation.

The fat content is read directly via a specially calibrated butyrometer.

Gerber developed specialized butyrometers (tubes), pipettes, and centrifuges.

Water baths built specifically for the Gerber tubes are often used.

3.3.2 Babcock test procedure

The test is based on the observation that a suitable amount of sulfuric acid added to the milk will dissolve proteins and other components, except the fat.

This method is an older version of the Gerber method

Heating and centrifuging cause the fat to separate and float to the top, in a layer free of bubbles.

The amount of fat in the milk can then be estimated from the volume of that layer.

The procedure was commonly carried out in a special flask with a long neck, called a Babcock bottle.

3.4. Hydrometer

A hydrometer or lactometer is an instrument used for measuring the density or relative density of liquids based on the concept of buoyancy. They are typically calibrated and graduated with one or more scales such as specific gravity.

Used to measure the density of milk.



Lactometer

Working Principle

1. A hydrometer usually consists of a sealed hollow glass tube with a wider bottom portion for buoyancy, a ballast such as lead or mercury for stability, and a narrow stem with graduations for measuring.

The liquid to test is poured into a tall container, often a graduated cylinder, and the hydrometer is gently lowered into the liquid until it floats freely.

The point at which the surface of the liquid touches the stem of the hydrometer correlates to relative density.

Hydrometers can contain any number of scales along the stem corresponding to properties correlating to the density

3.5. DEXA (Dual Energy X-Ray Absorption)

Dual-energy X-ray absorptiometry (DXA, or DEXA) is a means of measuring bone mineral density (BMD) using spectral imaging.

It performs fat measurement and contaminant detection for fresh, chilled, frozen and hot-boned loose bulk, frozen or tempered (“naked”) meat blocks and unwrapped meat conveyed in plastic crates.

Working Principle

Two X-ray beams, with different energy levels, are aimed at the patient's bones. When soft tissue absorption is subtracted, the bone mineral density (BMD) can be determined from the absorption of each beam by bone.



FAT ANALYSIS X-RAY

3.6. NMR Technology

Nuclear magnetic resonance (NMR) is a physical phenomenon in which nuclei in a strong constant magnetic field are perturbed by a weak oscillating magnetic field (in the near field) and respond by producing an electromagnetic signal with a frequency characteristic of the magnetic field at the nucleus.

Moisture and
Fat in Meats

Moisture/
Solids and
Fat in Dairy
Products

Uses



Rapid NMR Fat Analyzer

4. Conclusion

- For both customers and members of the food business, food fat content has always been a topic of intense debate and scrutiny.
- Customers desire a product that accurately and independently verifies the amount of fat in food, but the process of assessing fat content can be confusing, especially given the wide variety of fats and testing methods available.

5. Reference

- <https://www.medallionlabs.com/blog/analyzing-fat-in-food/>
- https://en.wikipedia.org/wiki/Gerber_method
- https://en.wikipedia.org/wiki/Babcock_test
- <https://en.wikipedia.org/wiki/Hydrometer>
- https://en.wikipedia.org/wiki/Dual-energy_X-ray_absorptiometry
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