

**Africa institute for project management studies**

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**Human Nutrition and Dietetics**.

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**Mogga Julious Alex**

**Juba, South Sudan.**

1. **Explain the different characteristics of foods are analyzed**

Foods are analyzed by the food industry including food manufacturers, ingredient suppliers, analytical service laboratories, government laboratories, and institutional research laboratories. Foods should conform to government regulations and recommendations that are designed to maintain the general quality of food supply, ensure food industry provides consumers with wholesome and safe foods, inform consumers about nutritional composition of foods so that they can make informed choices about their diet, to enable fair competition amongst food companies, and to eliminate economic fraud.

Food analysis is the discipline dealing with development, application and study of analytical procedures for characterizing the properties of foods and their constituents. The analytical procedures are used to provide information about foods: composition, structure, physicochemical properties and sensory attributes.

Standards Government agencies have specified a number of voluntary and mandatory standards concerning the composition, quality, inspection, and labeling of specific food products.

Nutritional Labeling of food products should have standardized nutritional labels so that consumers could make informed choices about their diet. Nutritional labels show total calorific value of food, total fat, saturated fat, cholesterol, sodium, carbohydrate, dietary fiber, sugars, protein, vitamins, calcium and iron. Labels may also contain information about nutrient content claims (such as “low fat”, “low sodium” “high fiber” “fat free”)

Food Safety one of the most important reasons for analyzing foods from both consumers and manufacturers standpoint is to ensure that they are safe. A food may be considered unsafe because it contains harmful microorganisms (e.g., Listeria, Salmonella), toxic chemicals (e.g., pesticides, herbicides) or extraneous matter (e.g., glass, wood, metal, insect matter). Food safety can be achieved by following “good manufacturing practice” regulations specified by the government for specific food products and by having analytical techniques that are capable of detecting harmful substances.

Quality control to increase market-share and profits food manufacturers ensure that their products are of higher quality, are safe and nutritious. Food materials must be analyzed before, during and after the manufacturing process to ensure that the final product meets the desired standards. Characterization of raw materials to ensure that they meet certain minimum standards of quality that have previously been defined by the manufacturer.

**B. Explain the criteria used in selecting an appropriate Technique for food analysis.**

Food analysis is the discipline dealing with development, application and study of analytical procedures for characterizing the properties of foods and their constituents. The analytical procedures are used to provide information about foods: composition, structure, physicochemical properties and sensory attributes.

The following are the procedures for selecting an appropriate technique for food analysis.

Precision: A measure of the ability to reproduce an answer between determinations performed by the same scientist (or group of scientists) using the same equipment and experimental approach.

Reproducibility: A measure of the ability to reproduce an answer by scientists using the same experimental approach but in different laboratories using different equipment.

Accuracy: A measure of how close one can actually measure the true value of the parameter being measured, e.g., fat content, or sodium concentration.

Simplicity of operation: A measure of the ease with which relatively unskilled workers may carry out the analysis.

Cost: The total cost of the analysis, including the reagents, instrumentation and salary

Speed: The time needed to complete the analysis of a single sample or the number of samples that can be analyzed in a given time.

Sensitivity: A measure of the lowest concentration of a component that can be detected by a given procedure.

Specificity: A measure of the ability to detect and quantify specific components within a food material, even in the presence of other similar components, e.g., fructose in the presence of sucrose or glucose.

Safety: Many reagents and procedures used in food analysis are potentially hazardous e.g. strong acids or bases, toxic chemicals or flammable materials.

On-line/Off-line: Some analytical methods can be used to measure the properties of a food during processing, whereas others can only be used after the sample has been taken from the production line.

Official Approval: Various international bodies have given official approval to methods that have been comprehensively studied by independent analysts and shown to be acceptable to the various organizations involved.

Nature of Food Matrix: The composition, structure and physical properties of the matrix material surrounding the analyse often influences the type of method that can be used to carry out an analysis, e.g., whether the matrix is solid or liquid, transparent or opaque, polar or non-polar.

1. **Discuss the changes that may occur in a sample before actual analysis and how they can be prevented.**
2. **Explain the principle of moisture determination by evaporation devices, distillations methods, chemical reaction methods and physical methods.**

Evaporation devices the thermal energy used to evaporate the water from a food sample can be provided directly (e.g., transfer of heat from an oven to a food) or indirectly (e.g., conversion of electromagnetic radiation incident upon a food into heat due to absorption of energy by the water molecules).

Distillation methods. These are based on direct measurement of the amount of water removed from a food sample by evaporation: percentage Moisture = 100 (MWATER/MINITIAL). In contrast, evaporation methods are based on indirect measurement of the amount of water removed from a food sample by evaporation:

Distillation methods involve heating a weighed food sample (MINITIAL) in the presence of an organic solvent that is immiscible with water. The water in the sample evaporates and is collected in a graduated glass tube where its mass is determined (MWATER).

Reactions between water and certain chemical reagents can be used as a basis for determining the concentration of moisture in foods. A chemical reagent is added to the food that reacts specifically with water to produce a measurable change in the properties of the system, e.g., mass, volume, pressure, pH, color, conductivity.

Measurable changes in the system are correlated to the moisture content using calibration curves. For accuracy, the chemical reagent need to react with all the water molecules present, but not with any of the other components in the food matrix. Two methods that are commonly used in the food industry are the Karl-Fisher titration and gas production methods. Chemical reaction methods do not usually involve the application of heat and so they are suitable for foods that contain thermally labile substances that would change the mass of the food matrix on heating (e.g., food containing high sugar concentrations) or foods that contain volatile components that might be lost by heating (e.g. spices and herbs).

1. **Describe analysis of lipid oxidation by oxygen uptake, TBARs and Peroxide Value methods.**

Batch Solvent Extraction. It is based on mixing the sample and solvent in a suitable container, e.g., a separator funnel. The container is shaken vigorously and the organic solvent and aqueous phase are allowed to separate (by either gravity or centrifugation). The aqueous phase is then decanted off, and the concentration of lipid in the solvent is determined by evaporating the solvent and measuring the mass of lipid remaining: percentage Lipid = 100 x (Mlipid/Msample).

Semi-Continuous Solvent Extraction. Semi-continuous solvent extraction methods are used to increase efficiency of lipid extraction. The Soxhlet method is the most commonly semi-continuous method. A sample is dried, ground into fine particles and placed in a porous thimble. The thimble is placed in an extraction chamber, suspended above a flask containing the solvent and below a condenser. The 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. The solvent builds up in the extraction chamber and completely surrounds the sample. The 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. As the solvent passes through the sample, it extracts the lipids and carries them into the flask.

The lipids remain in the flask because of their low volatility. At the end of extraction (which lasts a few hours), the flask containing the solvent and lipid is removed, the solvent evaporated and the mass of lipid remaining measured (Mlipid). The percentage of lipid in the initial sample (Msample) can then be calculated: o percentage Lipid = 100 x (Mlipid/Msample).

Supercritical Fluid Extraction. Solvent extraction can be carried out using supercritical carbon dioxide (rather than organic liquids) as the solvent. When pressurized CO2 is heated above a certain critical temperature, it becomes a supercritical fluid, which has some of the properties of a gas and some of a liquid.

When it behaves like a gas, it easily penetrates into a sample and extracts the lipids, while as a fluid it dissolves a large quantity of lipids (especially at higher pressures).

Instruments based on this principle heat the food sample to be analyzed in a pressurized chamber and then mix supercritical CO2 fluid with it. The CO2 extracts the lipid, and forms a separate solvent layer, which is separated from the aqueous components. The pressure and temperature of the solvent are then reduced causing the CO2 to turn to a gas, leaving the lipid fraction remaining. The lipid content of the sample is determined by weighing lipid extracted.

No solvent Liquid Extraction Methods. A number of liquid extraction methods do not use organic solvents, but use other chemicals to separate lipids from food matrix. The Babcock, Gerber and detergent methods are examples of nonsolvent liquid extraction methods for determining the lipid content of milk and some other dairy products.

Babcock Method. A milk sample is pipetted into a specially designed flask (the Babcock bottle). Sulfuric acid is mixed with the milk. This digests the protein, generates heat, and breaks down the fat globule membrane that surrounds the droplets, thereby releasing the fat. The sample is centrifuged while hot (55-60oC) causing the liquid fat to rise into the neck of the Babcock bottle.

The neck is graduated to give the amount of milk fat present in wt. percentage. The Babcock method takes about 45 minutes to carry out, and is precise to within 0.1%. It does not determine phospholipids in milk, because they are located in the aqueous phase or at the boundary between the lipid and aqueous phases.

Gerber Method. This method is similar to the Babcock method except that a mixture of sulfuric acid and isogamy alcohol, and a slightly different shaped bottle, are used. It is faster and simpler to carry out than the Babcock method. The isogamy alcohol is used to prevent charring of the sugars by heat and sulfuric acid, which can be a problem in the Babcock method since it, makes it difficult to read the fat content from the graduated flask. As with the Babcock method, it does not determine phospholipids.

Detergent Method. A sample is mixed with a combination of surfactants in a Babcock bottle. The surfactants displace the fat globule membrane, which surrounds the emulsion droplets in milk and causes them to coalesce and separate. The sample is centrifuged which allows the fat to move into the graduated neck of the bottle, where its concentration can then be determined.

**b. Describe analysis of lipid oxidation by oxygen uptake, TBARs and Peroxide Value methods.**

5. Describe protein determination by Kjeldahl, Dumas methods and UV-visible techniques.

Johann Kjeldahl developed the Kjeldahl method in 1883. A food is digested with a strong acid so that it releases nitrogen, which can be determined by a suitable titration technique. The amount of protein present is then calculated from the nitrogen concentration of the food.

Considered the standard method of determining protein concentration. Because the Kjeldahl method does not measure the protein content directly, a conversion factor (F) is needed to convert the measured nitrogen concentration to a protein concentration. A conversion factor of 6.25 (equivalent to 0.16 g nitrogen per gram of protein) is used for many applications, however, this is only an average value, and each protein has a different conversion factor depending on its amino-acid composition.

The Kjeldahl method can conveniently be divided into three steps: digestion, neutralization and titration.

Principles Digestion. The food sample to be analyzed is weighed into a digestion flask and digested by heating it in the presence of sulfuric acid (an oxidizing agent that digests the food), anhydrous sodium sulfate (to speed up the reaction by raising the boiling point) and a catalyst, such as copper, selenium, titanium, or mercury.

Digestion converts any nitrogen in the food (other than that which is in the form of nitrates or nitrites) into ammonia, and other organic matter to C02 and H20. Ammonia gas is not liberated in an acid solution because the ammonia is in the form of the ammonium ion (NH4+) which binds to the sulfate ion (SO42-) and thus remains in solution: N(food) → (NH4)2SO4 (1) Neutralization. After digestion, the digestion flask is connected to a receiving flask by a tube. The solution in the digestion flask is then made alkaline by addition of sodium hydroxide, which converts the ammonium sulfate into ammonia gas: (NH4)2SO4 + 2 NaOH → 2NH3 + 2H2O + Na2SO4 (2)

The ammonia gas is liberated from the solution and moves out of the digestion flask and into the receiving flask - which contains an excess of boric acid. The low pH of the solution in the receiving flask converts the ammonia gas into the ammonium ion, and simultaneously converts the boric acid to the borate ion: NH3 + H3BO3 (boric acid) → NH4+ + H2BO3- (borate ion) (3)

Titration  Nitrogen content is estimated by titration of ammonium borate with standard sulfuric or hydrochloric acid, using a suitable indicator to determine the end-point of the reaction. H2BO3- + H+ → H3BO3 (4)

Concentration of hydrogen ions (in moles) required to reach the end-point is equivalent to the concentration of nitrogen that was in the original food (Equation 3).