CHAPTER-I
INTRODUCTION

Food testing is the discipline dealing with the development, application and study of analytical procedures for characterizing the properties of foods and their constituents. These analytical procedures are used to provide information about a wide variety of different characteristics of foods, including their composition, structure, physicochemical properties and sensory attributes. This information is critical to our rational understanding of the factors that determine the properties of foods, as well as to our ability to economically produce foods that are consistently safe, nutritious and desirable and for consumers to make informed choices about their diet. The objective of the food testing is to review the basic principles of the analytical procedures commonly used to analyse foods and to discuss their application to specific food components, e.g. lipids, proteins, water, carbohydrates and minerals.

1.1 REASON FOR ANALYSING FOOD

Foods are analysed by scientists working in all of the major sectors of the food industry including food manufacturers, ingredient suppliers, analytical service laboratories, government laboratories, and University research laboratories.

1.2 GOVERNMENT REGULATION AND RECOMMENDATION

Government regulations and recommendations are designed to maintain the general quality of the food supply, to ensure the food industry provides consumers with foods that are wholesome and safe, to inform consumers about the nutritional composition of foods so that they can make knowledgeable choices about their diet, to enable fair competition amongst food companies, and to eliminate economic fraud. There are a number of Government Departments Responsible for regulating the composition and quality of foods, including the Food and Drug Administration (FDA), the United States Department of Agriculture (USDA), the National Marine Fisheries Service (NMFS) and the Environmental Protection Agency (EPA). Each of these government agencies is responsible for regulating particular sectors of the food industry and publishes documents that contain detailed information about the
regulations and recommendations pertaining to the foods produced within those sectors. These documents can be purchased from the government or obtained on-line from the appropriate website.

1.2.1 STANDARD

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

1.2.1.1 Standards of Identity: These regulations specify the type and amounts of ingredients that certain foods must contain if they are to be called by a particular name on the food label. For some foods there is a maximum or minimum concentration of a certain component that they must contain, e.g., peanut butter must be less than 55% fat, ice-cream must be greater than 10% milk fat, cheddar cheese must be greater than 50% milk fat and less than 39% moisture.

1.2.1.2 Standards of Quality: Standards of quality have been defined for certain foods (e.g., canned fruits and vegetables) to set minimum requirements on the color, tenderness, mass and freedom from defects

1.2.1.3 Standards of Fill-of-Container: These standards state how full a container must be to avoid consumer deception, as well as specifying how the degree of fill is measured.

1.2.1.4 Standards of Grade: A number of foods, including meat, dairy products and eggs, are graded according to their quality from standard to excellent. For example meats can be graded as prime, choice, select, standard etc. according to their origin, tenderness, juiciness, flavour and appearance. There are clear definitions associated with these descriptors that products must conform to before they can be given the appropriate label. Specification of the grade of a food product on the label is voluntary, but many food manufacturers opt to do this because superior grade products can be sold for a higher price. The government has laboratories that food producers send their products too to be tested to receive the appropriate certification. This service is requested and paid for by the food producer.
1.3 FOOD INSPECTION AND GRADING

The government has a food inspection and grading service that routinely analyse the properties of food products to ensure that they meet the appropriate laws and regulations. Hence, both government agencies and food manufacturers need analytical techniques to provide the appropriate information about food properties. The most important criteria for this type of test are often the accuracy of the measurements and the use of an official method. The government has recently carried out a survey of many of the official analytical techniques developed to analyse foods, and has specified which techniques must be used to analyse certain food components for labelling purposes. Techniques have been chosen which provide accurate and reliable results, but which are relatively simple and inexpensive to perform.

1.4 FOOD SAFETY

One of the most important reasons for analysing foods from both the consumers and the manufacturers standpoint is to ensure that they are safe. It would be economically disastrous, as well as being rather unpleasant to consumers, if a food manufacturer sold a product that was harmful or toxic. A food may be considered to be 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). It is therefore important that food manufacturers do everything they can to ensure that these harmful substances are not present, or that they are effectively eliminated before the food is consumed. This 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. In many situations it is important to use analytical techniques that have a high sensitivity, i.e., that can reliably detect low levels of harmful material. Food manufacturers and government laboratories routinely analyse food products to ensure that they do not contain harmful substances and that the food production facility is operating correctly.
1.5 ACCOMMODATION AND ENVIRONMENT OF LABORATORY

1.5.1 The Codex guidelines for the design of food laboratories are applicable.

1.5.2 Laboratories should be designed to meet both the generic and specialised activities. Generic activities include wet chemistry, which requires extensive fixed benches with provision of water, power, sinks, cupboards, fume cupboards, reagent shelves, glassware cleaning and storage. In comparison, instrument rooms may have less extensive and even flexible arrangement of movable tables and benches.

1.5.3 Specialised rooms are required for clean-air-work or for work on substances, which need special care for reasons of safety (e.g., working with radioactive materials or storage or work on toxic substances).

1.5.4 Dust, both from environmental sources or from other samples, must be avoided since dust contamination of test materials is sporadic and uneven and is likely to be missed by normal quality control checks. Ventilation intakes and fume cupboard exhaust must be placed carefully so as to avoid re-circulation of laboratory air and the associated risk of contamination of test materials and hazard to laboratory staff. Work surfaces and floor shall be made of impervious, smooth, easy to clean materials. There shall be sufficient work place for each analyst. Walls and ceilings shall be made of materials that are smooth and easy to clean.

1.5.5 There shall be at least 300-lux light intensity at working surfaces other than those required for specified tests.

1.5.6 For certain chemical analysis, design of the laboratory needs to be specific to ensure segregation of trace analysis from highly concentrated formulations and from pure substances used in preparing analytical standards. The segregation must apply to all facilities for washing/cleaning equipment, washing and storage of glassware, use of protective clothing etc.

1.5.7 It is recommended that the media preparation and media/glassware sterilization areas be separated from the testing areas.

1.5.8 Laboratories located in facilities where products or ingredients are manufactured are not to test for infectious pathogens (such as Listeria monocytogenes, Salmonella species, Escherichia coli 0157:H7, Shigella species, Campylobacter species, Vibrio
cholera, Clostridium perfringens) unless the laboratory is physically separated with limited access, equipped with bio-safety cabinets and is supervised by a qualified microbiologist.

1.5.9 Environmental contamination by microorganisms is to be controlled by appropriate air-filters and air-exchange systems. Monitoring or control verification is to be performed using air sampling devices, air setting plates, surface swabs or other appropriate means. These checks are critical to aerobic plate count procedures and yeast and mould tests and their equivalent is desirable in trace chemistry laboratories. Laminar flow, positive pressure or such environment shall be provided, wherever necessary.

1.5.10 Eating, drinking and smoking should be prohibited in the laboratory. Separate area, physically separated from the laboratory, may be provided for such activities.

1.5.11 Entry in laboratory areas shall be restricted as appropriate for reasons such as security, safety or sensitivity to contamination. Where such restrictions are in force, staff shall be made aware of the intended use of the areas and the restrictions imposed on working within such areas.

1.5.12 The responsibility for the house keeping activities must be clearly defined with respect to the following duties:
   a) Cleaning of floors, vertical surface, horizontal surface, interiors of refrigerators, freezers, fume cupboards, controlled environment store.
   b) Control of contents of refrigerator, freezer, fume cupboards, controlled environment store.
   c) Checking the performance of air-conditioning of dust extraction equipment and fume cupboards.

1.5.13 It is important for laboratories to have a pest control programme/schedule.

1.5.14 The laboratory is to have adequate fire safety measures, (Anon., 2005)

1.6 ASSURING THE QUALITY OF TEST RESULTS

Laboratories should have quality control procedures in place with rigor appropriate to the test and its intended use. For example, the approach may differ if a substance is banned by law or if there is a regulatory limit for the substance. The
laboratory should implement a quality control plan. Typically, this plan should include blanks, control samples, spike recoveries and/or duplicates, where applicable.

Laboratories are required to take part in APLAC/ EA/ NABL or other Proficiency Testing Programmes, which are conducted in accordance with ISO/ IEC Guide 43. Proficiency testing records should include:

Full details of the analyses, examination, undertaken and the results and conclusions obtained;

• Details of the investigations and corrective action undertaken, where necessary. (Anon., 2012)

1.7 NUMBER OF NABL-ACCREDITED LABS IN WORLD

In the world there were 970 labs available. It include 319 labs for chemical, 86 for electrical, 62 for mechanical, 7 for biology, 202 for chemical and mechanical, 83 for biology and chemical, 26 for chemical, biological and mechanical, 15 for chemical, mechanical and electrical, 7 for forensic and 163 others. (Anon., 2012)

1.8 TYPES OF SAMPLES

1.8.1 Official sample: Sample taken in a manner so that it can serve as the basis for enforcement and/or legal action and handled in a manner that preserves integrity as evidence including identity, ownership, traceability and a clear record of chain of custody.

1.8.2 Investigation sample: Taken during a food safety inspection to document inspector, observations, support regulatory actions or provide other information.

1.8.3 Surveillance sample: Taken as part of routine inspections or surveys to identify any lack of compliance with state, federal or other laws and regulations.

1.8.4 Documentary samples: Evidenced of sample is collected such as labelling, photos, drawings, invoices, transportation records, inventory which may be used in investigations or connection to previously collected samples.

1.8.5 Emergency response: Taken during an investigation for food borne illness or in response to a food related emergency.

1.8.6 Food borne outbreak: An incident in which two or more persons experience a simple illness resulting from ingestion of a common food.

1.8.7 Convenience sample: A sample chosen on the basis of accessibility, expediency, cost or efficiency but may not be representative of the whole lot of food
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or feed. These may sometimes be surveillances samples but may also be samples taken in response to a consumer complaint or incident.

1.8.8 Import/ Import domestic: Foreign products which have not yet cleared customers are “imports” and foreign products which have cleared customers are “domestic imports.” A foreign product which is manipulated in a major manner, which changes the products or composition, is no longer considered an import under U.S. law.

1.8.9 Monitoring sample: Used to collect information such as incidence, number and species of foodborne pathogens in food or the incidence, amount and frequency of chemical ingredients, additives, residues or contaminants but not intended to support regulatory action.

1.8.10 Violation: A sample found to be non-compliant with established food laws/codes/regulations.

1.8.11 Compliance sample: Taken to determine compliance with specific food laws/code often as a follow-up to a violate finding in a surveillance sample.

1.8.12 Low enforcement sample: Taken during a specific investigation by law enforcement to support possible legal action for non-compliance with federal, state or local regulations.

1.8.13. Laboratory sample: The sample or subsample sent to or received by the laboratory.

1.9 DESIGN OF SAMPLE CONTAINERS FOR FOODS

1.9.1 Frozen and refrigerated foods;
1.9.2 Highly Perishable foods;
1.9.3 Liquid foods;
1.9.4 Semi solid or viscous foods;
1.9.5 Fragile foods;
1.9.6 Solid dry foods;
1.9.7 Miscellaneous.

1.9.1 Frozen and refrigerated foods:

These require packaging materials having very good low temperature resistance, seal integrity, absence of corrosion and long durability. Packages made of
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all varieties of low and high-density polyethylene, PET/foil/PE pouches and bags and co-extruded structures based on PE, polyamides and polyester films shall be used. Cast polypropylene and glass containers should be avoided. Tinplate containers may corrode at the seams.

1.9.2 Highly perishable foods:

These comprise fresh fruits and vegetables meat, fish and poultry as well as marine products. All these products have moisture contents and hence have short shelf life due to microbiological and chemical deterioration, and also require clean and hygienic wraps. Partially permeable to water vapour and oxygen packaging materials such as low-density polyethylene, thin gauge polypropylene and polyvinyl chloride can be used. Completely impermeable packages are not recommended. Materials such as used jute bags should not be used.

1.9.3 Liquid foods:

These require absolute leak-proof, bacterial permeability as well as good mechanical protection. Many liquid foods are sensitive to radiation of visible and ultraviolet regions necessitating light opaque packaging.

For short-term storage, polyolefin films of more than 25 microns can be used. Glass and metal containers provide long term protection. Multi-layered flexible structures could also be used.

1.9.4 Semi-solid or viscous foods:

These have packaging requirements similar but less severe to those of liquid foods. Filling and dispensing pose problems.

Suitable containers include wide-mouth glass jars, and rigid plastic containers with appropriate closures.

1.9.5 Fragile foods:

These include food products like biscuits, paste products, confectionery and snack foods. These require greater physical or mechanical protection against breakage during transportation and storage. Packages with suitable constructional features such as cartons, boxes and with appropriate cushioning materials like expanded plastics are suitable.

1.9.6 Solid dry foods:

Most of the dry foods except those having high fat and volatiles contents require less stringent packaging conditions. They are predominantly sensitive to water vapour and hence require barrier materials.
Suitable containers for these solid dry foods include flexible packages made of monolayer or multilayer structures, paper-board containers with over wrap as well as lined packages.

1.10 CHALLENGES FACED BY FOOD TESTING LAB

The quality of testing has deteriorated in these labs across India due to some inherent problems

- Lack of adequate human resources
- Outdated infrastructure
- Shortage of chemicals to carry out tests
- Most of the state laboratories are not functional
- Financial constraints in most of the state laboratories
- Sample load is relatively high and most of the labs are not equipped to perform tests to check the presence of microbes, pesticides or metals.
- Most labs are capable of performing only chemical analysis and then the samples are sent to the private
- Process of collecting samples is lengthy. It takes an officer at least two to three hours to collect samples in accordance with legal norms.
- It takes almost a year to get all documents in place for prosecution.
- There’s only one designated court to hear cases related to food safety. Hence, the backlog is huge.

1.11 SCOPE OF FOOD TESTING LABORATORY

The scope of Food Testing Laboratories is applicable mainly to the following disciplines/areas of activity (any)

- Food Chemistry
- Food Microbiology;
- Food Rheology and other Physical Testing;
- Food Toxicology;
- Functional Testing;
- Molecular Biology (including genetically modified organisms);
- Sensory Testing.
1.12 IMPORTANCE OF FOOD TESTING

Foodborne bacteria can cause all sorts of problems. “Food poisoning” can foster mild to severe stomach discomfort, major gastrointestinal distress, nausea, vomiting, diarrhoea, dehydration, hospitalization and even death. Salmonella is most widely contracted from the ingestion of contaminated poultry meat but can be found in any raw meat, some dairy products, yeast and even coconuts. E coli can be particularly dangerous. Campylobacter has been identified as the bacterial cause of foodborne illness in the United States. It’s most commonly found in raw poultry, meat, and raw juices. While the food processing industry tries to identify and remove these toxic pathogens at several stages they are not always successful. It’s not just food that can harbour these bacteria but also food handling and preparation areas as well.

1.13 ABOUT LABORATORY

The food testing laboratory (FTL) at Junagadh Agricultural University, Junagadh is a joint venture of JAU, Ministry of food processing industries (New Delhi), ICAR and Gujarat Agro Industries Corporation.

The laboratory is the first of its kind providing professional interface to public and private sectors. This venture is in the infancy today but has National Accreditation board for testing and Calibration Laboratories (NABL) accreditation and will become an authentic agency for Quality Assurance and Quality Control.

INFRASTRUCTURE:

- Constructed Area : 40 m x 27 m
- Laboratories : 8
- Size of each laboratory : 10 m x 8 m

1.13.1 TYPE OF CELLS

Working range of cells and achievements of laboratory given annexure I and Annexure II respectively.

- **Separation cell**: Extraction and purification of the samples.
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- **Elemental cell**: Elemental analysis from different matrix of plant, soil and water.
- **Biotech cell**: GMO test, molecular biological work like DNA fingerprinting, RNA, DNA barcoding, sequencing, etc.
- **Microbial cell**: Qualitative and quantitative test of pathogenic micro flora in foods, vegetables and fruit.
- **General Food Quality Assessment cell**: Proximate biochemical assay of foods, vegetables and fruits and quality assurance to exporters.
- **Proteomic cell**: Protein analysis from various plants, microorganism and animal samples.
- **Nanotech cell**: Analysis of Nano particles presents in food sample and thereby prediction of food sampling of food spoiling, infection and quality control.
- **MS/MS cell**: Qualitative and quantitative assay of pesticide residues, mycotoxins and other toxic proteins present in unknown food sample.
- **Training cell**: Short and long term training for assay of different food quality parameters and handling the sophisticated instruments to get expertise.

1.14 PRACTICAL UTILITY OF THE RESEARCH STUDY

The present study will be useful to the food testing laboratory. The customer profile useful to know socio-economic profile of the farmer who is customer of food testing laboratory. The pattern of sample arrival will be helpful to know which type of more sample arrival into lab and also know the growth of sample arrival year by year. The establishment cost will be helpful to know the total cost of laboratory which is helpful for starting new unit. In financial performance work out the ratios, NPV, IRR, BEP etc. which is useful to know profitability of the laboratory, present value of the laboratory and requirement of working capital.

1.15. OBJECTIVES OF THE STUDY

1. To study customer profile
2. To study the pattern of sample arrival
3. To work out the establishment cost of laboratory
4. To evaluate financial performance
1.16. LIMITATIONS OF THE STUDY

1. The sample size that has to selected was small in size due to limited time.

2. Some secondary quantitative data was used.
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