Methods for Food Analysis and Quality Control

Chapter · January 2019

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CHAPTER 10

METHODS FOR FOOD ANALYSIS AND QUALITY CONTROL

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10.1 INTRODUCTION

Food is a more basic need of human than that of shelter and clothing. It provides adequately for the body's growth, maintenance, repair, and reproduction. Plant and animal origin are the sources of foods that contain the essential nutrients such as carbohydrates, fats, proteins, vitamins, and minerals. Usually after consumption, food undergoes different metabolic processes that eventually lead to production of energy, maintenance of life, and/or stimulation of growth.[3]

Food analysis is the process for both fresh and processed products by the standardized form and are those most commonly used in the laboratory. These analytical procedures are used to provide information about a wide variety of different characteristics of foods, including their composition, structure, physicochemical properties, phytochemical 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.

Quality control is the standards which maintain the quality of the food products according to the customer's acceptability. Physical, chemical, microbiological, nutritional, and sensory parameters are used for the maintenance of nutritious food. These quality factors depend on specific attributes such as sensory properties, based on flavor, color, aroma, taste, texture and quantitative properties, namely, percentage of sugar, protein, fiber and so on as well as hidden attributes such as peroxides, free fatty acids, enzyme.[1,2,13,18] Although quality attributes are many, yet not all need to be considered at every point in time for every particular product. It is important to always determine how far relatively a factor is related to the total quality of the product. The quality attribute of a particular product is based on the composition of the product, expected deteriorative reactions, packaging used, shelf-life required, and the type of consumers.

The most important element and ultimate goal in food quality control is protecting the consumer. To ensure standardization of these procedures, food laws and regulations cover the related acts affecting the marketing, production, labeling, food additive used, dietary supplements, enforcement of good manufacturing practice (GMP), hazard analysis and critical control point (HACCP), federal laws and regulations, factory inspections, and import/export inspections.[2,8,19]

This chapter discusses attributes and parameters that are essential in food analysis and quality control.

10.2 FOOD QUALITY

10.2.1 QUALITY PARAMETERS

In order to ensure the right quality of various food products, several parameters are evaluated by different methods:

- Physicochemical and rheological parameters (Table 10.1).
- Phytochemical parameters (Table 10.2).
- Packaging materials (Table 10.3).

TABLE 10.1 Physicochemical and Rheological Parameters for Quality of Selected Food Products.

Parameter name	Instruments and chemicals used	Products
Admixture	Visual observation	Cereals, pulses
Bellier turbidity temperature	Visual	Oils
Bulk density	Calibrated graduated cylinder	Cereal, fruits, and vegetables and other products
Color on Lovibond scale	Lovibond Tintometer	Oil, fat
Crude fiber	Chemical	Most of the fruits and vegetables and cereal products
Fat or oil	Chemical and soxhlet method	Most of the food products, animal feeds
Insect infestation	Visual observation	Cereals, pulses

TABLE 10.1 *(Continued)*

Parameter name	Instruments and chemicals used	Products
Moisture	Hot-air oven Vacuum oven Karl Fischer titer Dean and Stark	Most of the food products, animal feeds
Oil-holding	Centrifuge	Cereal products, other powder products
Optical rotation	Polarimeter	Sugar, syrup, oil and fat
Protein	Chemical and Kjeldahl method	Most of the food products, animal feeds
Refraction	Sieve test	Flour
Starch	Chemical	Starch containing products
Swelling	Centrifuge	Cereal products, other powder products
True density	Gas Pycnometer–volumetric analyzer	Cereal products, other powder products
Water-retention	Centrifuge	Cereal products, other powder products
Water-solubility index	Centrifuge	Cereal products, other powder products

TABLE 10.2 Phytochemical Parameters for Quality of Selected Food Products.

Parameter name	Instruments and chemicals used	Products
Anthocyanins	Chemical and spectrophotometer	Red color-rich fruits and vegetables and other food products
Antioxidant activity	Chemical and spectrophotometer	Most of the fruits and vegetable products
Ascorbic acid	Chemical and titration method	Most of the fruits and vegetable products
Lycopene	Chemical and spectrophotometer	Colored fruits and vegetables and other products
Total carotenoids and β-carotene	Chemical and spectrophotometer	Yellow color rich food products
Total phenols	Chemical and spectrophotometer	Most of the fruits and vegetable products

TABLE 10.3 Packaging Materials for Quality of Selected Food Products.

Parameter name	Instruments and chemicals used	Products
Heavy metals: Pb, As, Cd, Se, Ba	AAS	Colored plastics
Laquer	Physical Chemical	Tin cans
Migration tests	Chemical	Food grade plastics
Sulfide stain	Chemical	Food cans
Tin, chromium	AAS	Tin plate
Water vapor permeability	Humidity chamber	Plastics

10.2.2 BENEFITS OF FOOD ANALYSIS

Food analyses are used for the removal of toxic substances from the food products. It increases the shelf-life of the foods during storage and deteriorates the quality of the food products. Foods are safe to spoilage and microorganisms by the analyses. It improves the quality of life for people with allergies, diabetics, and other people, who cannot consume some common food elements. It adds extra nutrients such as vitamins.

10.2.3 INSTRUMENTAL TECHNIQUES FOR FOOD QUALITY

These techniques are used for the evaluation of organoleptic quality of food products. Different types of instruments are used for the analysis of food products, that is, gas chromatography, spectrophotometer, electronic nose, and so on.

10.2.3.1 GAS CHROMATOGRAPHY-OLFACTOMETRY (GC-O)

The gas chromatography method is based on sensory evaluation of the eluate (Figs. 10.1 and 10.2). Identification of aroma active compounds is possible on the basis of simultaneous use of the second detector. Mostly, second detector function performs mass spectrometer (MS) or flame-ionization detector (FID).

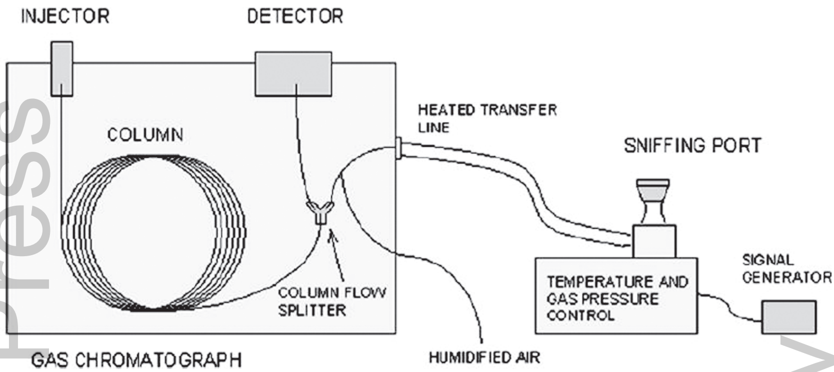

FIGURE 10.1 Gas chromatograph coupled with olfactometric detector.

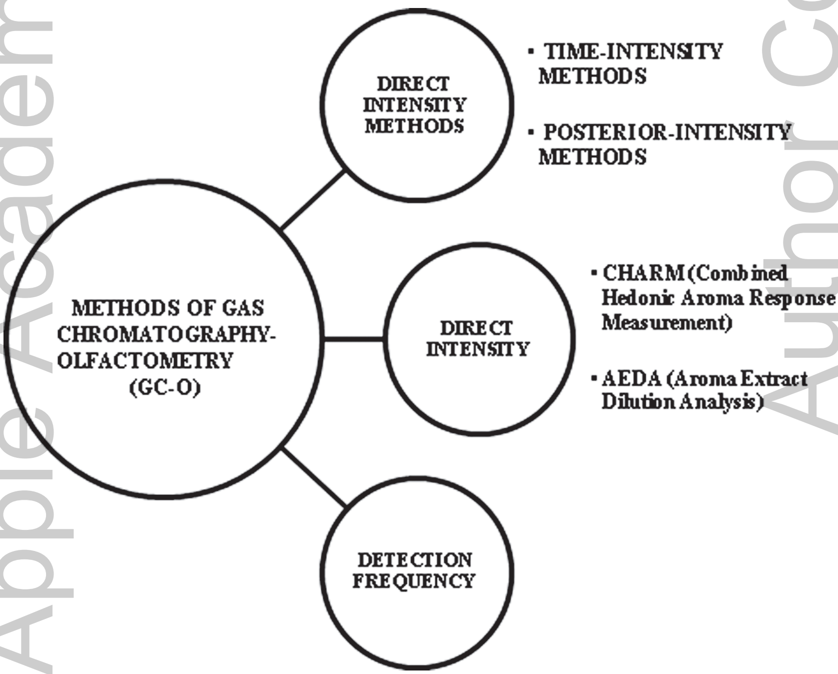

FIGURE 10.2 Flow diagram for methods for GC-O.

10.2.3.1.1 Spectrophotometer

Spectrophotometric techniques are used to measure the concentration of solutes in solution by measuring the amount of light that is absorbed by the solution in a cuvette placed in the spectrophotometer. Spectrophotometry takes advantage of the dual nature of light. Namely, light has:

- A particle nature which gives rise to the photoelectric effect.
- A wave nature which gives rise to the visible spectrum of light.

10.2.3.1.2 Electronic Nose

Electronic nose consists of electrochemical sensors (Fig. 10.3). It is selective for certain volatile compounds. The system is capable for the identification of simple and complex odors. It is used mainly in the food industry for the detection of different aromatic compounds (Fig 10.4).

10.2.4 DRAWBACKS OF FOOD QUALITY

- To affect its nutritional density, the amount of nutrients lost depending on the food and method of processing.
- By the heat treatment, vitamin C is destroyed. Fresh fruit juices have high content of vitamin C than processed fruit juice.
- Large mixing, grinding, chopping and emulsifying equipment, inherently introduce a number of contamination risks.
- Large food processors will utilize many metal within the processing stream, metals may be dangerous for our health.

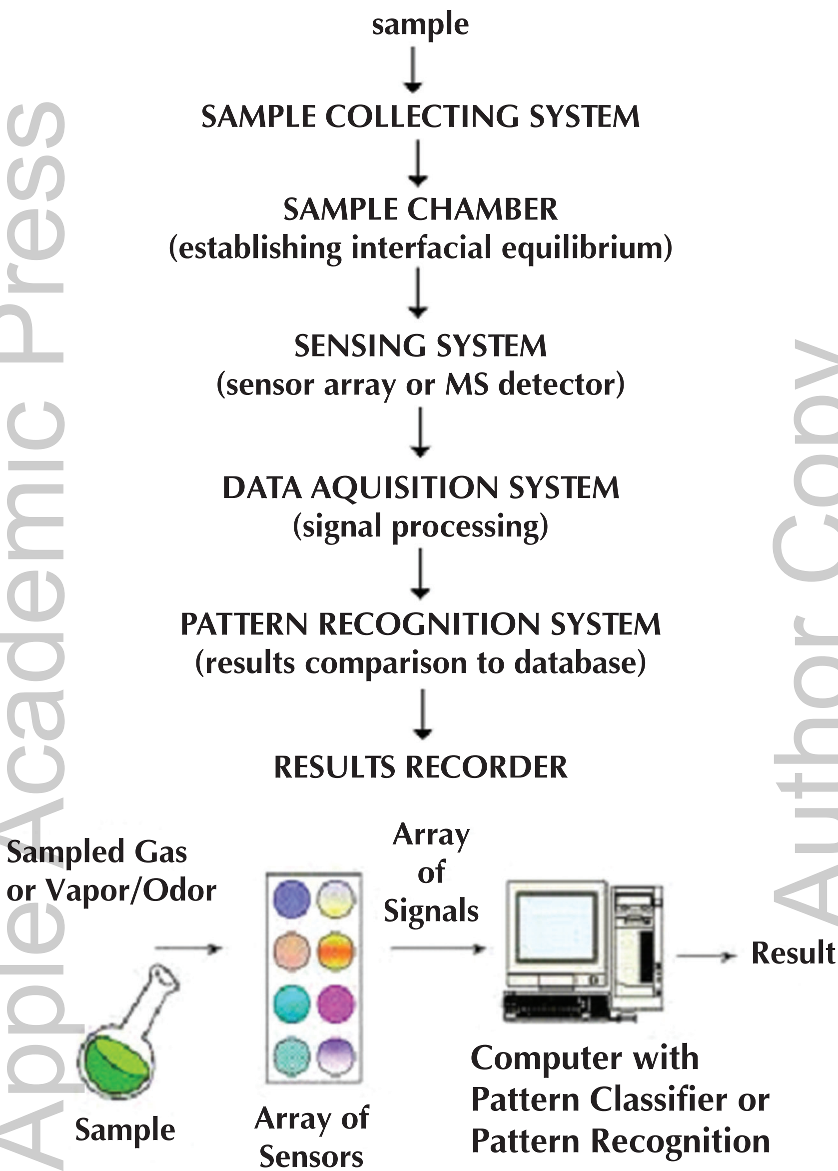

FIGURE 10.3 Electronic sensory machine (electronic nose).

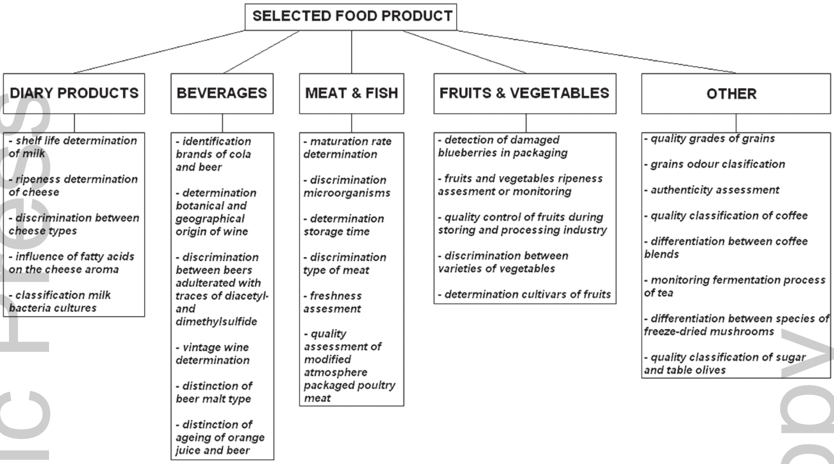

FIGURE 10.4 Food products for use in electronic sensory machine.

10.2.5 REASONS FOR ANALYZING FOODS

Foods are analyzed 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.

10.2.6 GOVERNMENT REGULATIONS AND RECOMMENDATIONS

The government has designed and recommended regulations to maintain the quality of food products, ensure food companies to supply safe and wholesome food to the consumers, inform consumers about the nutritional composition of foods, enable fair competition among food companies, and to eliminate economic fraud. There are various government departments responsible for regulating the composition and quality of foods, such as the US 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 agencies regulates a particular sector of food industry and also publishes the documents that contain detailed information about the regulations and recommendations. These documents can be purchased from the government or can be obtained online website.

10.2.7 FOOD SAFETY

It is harmful for the consumers to consume unsafe foods. A food may be considered unsafe when it contains harmful microorganisms (e.g., Listeria, Salmonella), toxic chemicals (e.g., pesticides, herbicides) or extraneous matter (e.g., glass, wood, metal, insect matter). Therefore, food manufacturers should take all the preventive measures to eliminate these harmful substances from food. Government laboratories use analytical techniques to analyze food and detect toxic substances and also to ensure that the food is safe for consumers.

10.3 QUALITY CONTROL

To make high profit and market share, food manufacturers are continuously trying to have products of higher quality, and less expensive than the other competitive products. Analytical techniques to analyze food are required to meet these standards during and after manufacturing of food products. In a food factory, one starts with a number of different raw materials, processes them in a certain manner (e.g., heat, cool, mix, dry), packages them for consumption and then stores them. The food is then transported to a warehouse or retailer where it is sold for consumption. The important concern of the food manufacturers is to produce a final product that has all acceptable properties such as appearance, texture, flavor and shelf-life. When we purchase a product, we expect it to have same properties whenever we buy it. However, the raw materials for manufacturing of product vary from time to time, which can cause the properties of the final product to vary, often in an unpredictable way. First, they have to understand that different food ingredients and processing operations are important in determining the final properties of food so that they can be controlled during the manufacturing process of final product. This type of information can be established through research and development work. Second, they can monitor the properties of foods during production to ensure that they are meeting the specified requirements, and if a problem is detected during the production process, appropriate actions can be taken to maintain final product quality.

10.3.1 METHODS OF FOOD QUALITY CONTROL

In addition to ensuring safe and healthy food for the consumer, product manufacturers and service industries have realized that competition in a global market requires a continual and committed effort towards the improvement of product and service quality. Therefore, they follow the process improvement cycle comprising:

- PLAN (plan improvement)
- DO (implement plan for improvement)
- CHECK (analyze the collected data)
- ACT (take action)

Quality control process consists of raw materials, in-process, product and service. The major factors in process that cause variability in quality of finished product are people, equipment, and methods or technologies employed in the process. The use of proper statistical process control methods is also vital for assurance of the product quality. Usually, the value of quality characteristics is used to provide feedback on how processes may be improved. Statistical quality control consists of the following procedures:

- Finished product is measured.
- Sampling occurs for days or weeks.
- Lot is either accepted or rejected based on the information from sample.

Contrary to statistical quality control, statistical process control methods focus on identifying factors in process that cause variability in finished product, eliminating the effect of these factors before worse product is manufactured, and control charts give online feedback of information about process.[11,18] Food quality control measures have continuously been improved since the 20th century, owing largely to the implementation of good practices, quality systems, and increased traceability in food production. Ever since microorganisms were discovered in our environment and linked to typhoid fever and other diseases that have plagued humanity, public health, authorities have been concerned with the accumulation of filth and foul odors in urban areas.[18] The first early inspection systems based on sensory evaluations were legally enforced at the beginning of the 20th century. Initial bacteriological techniques to detect pathogenic bacteria in foods, such as shellfish, appeared soon after.[18] From that point on, the food and beverage industry has applied stricter product inspection procedures and more and more effective production methods to conserve the freshness of natural raw materials.

Today, the establishment of GMP and good hygienic practices (GHP) in many countries has significantly reduced the risk of spoilage and pathogenic microorganisms in modern food products. In addition to comply with national and international food regulations, food manufacturers are required to follow international quality standards, such as ISO as well as the HACCP system. In recent years, there has been an increasing focus on traceability in food production.[18] This has followed public concerns arising from cases of food contaminations and the development of foods containing ingredients derived from genetically modified (GM) crops. In light of increasing need for food more rapid food testing, it became clear that the traditional microbiological detection and identification methods for foodborne pathogens were no longer effective. Because, it was time-consuming and laborious to perform, and was increasingly unable to meet the demands for rapid quality control. A rapid method is generally characterized as a test giving quicker results than the standard accepted method of isolation and biochemical and/or serological identification.[18]

10.3.1.1 ION MOBILITY SPECTROMETRY OR DIFFERENTIAL MOBILITY SPECTROMETRY

Ion mobility spectrometry (IMS) and differential mobility spectrometry (DMS) are the methods used in the identification and quantification of analysts with high sensitivity. The selectivity can even be increased as necessary for the analyses of complex mixtures-using pre-separation techniques such as gas chromatography or multi-capillary columns (MCC). The method is suitable for application in the field of food quality and safety including storage, process and quality control as well as the characterization of foodstuffs.[23]

10.3.1.2 IMMUNOCHEMICAL METHODS

This method is based on antigen–antibody interaction. The antibodies are highly specific for the antigen, and secondly, the antigen, the antibody, or an anti-globulin may be conjugated to an enzyme that produces an intensely colored or fluorescent product in the presence of the enzyme substrate to enhance the detectability of analyze in an amplification step.

10.3.1.3 ENZYME IMMUNO ASSAY (EIA)

In recent years, the EIA using monoclonal antibodies have made available rapid and consistent microbiological detection systems. The most widely used systems employ a sandwich technique using antibody attached to a polystyrene matrix to which the sample is added. Post incubation, a second antibody, which is specific for the organism and has been tagged with an enzyme, is added. The addition of enzyme substrate to the mixture completes the EIA. The presence of the specific organism results in a colorimetric change in the enzyme substrate, which may be observed visually or with a spectrophotometer. Most EIA are very specific but lack sensitivity. Normal sensitivity has been reported to be approximately 106 org/ml.[9]

10.3.1.4 BIOSENSORS

Biosensor is usually a device or instrument comprising a biological sensing element coupled to a transducer for signal processing.[22] Biological sensing elements include enzymes, organelles, antibodies, whole cells, DNA, and tissues. There are different types, conductance bioluminescence enzyme sensors utilizing potentiometric, amperometric, electrochemical, optoelectric, calorimetric, or piezoelectric principles. Basically, all enzyme sensors work by immobilization of the enzyme system onto a transducer.[22] This technique provides sensitive and miniaturized systems that can be used to detect unwanted microbial activity or the presence of a biologically active compound, such as glucose or a pesticide in food. Immunodiagnostics and enzyme biosensors are two of the leading technologies that have had the greatest impact on the food industry.[9]

10.3.1.5 FLOW CYTOMETRY (FCM)

Specific detection of pathogenic strains can be accomplished by flow cytometry using immunofluorescence techniques, which allow microorganism detection at the single-cell level. Although this technology can be used for food samples, it requires prior isolation of the target organism to generate antibodies.[6] FCM finds wide application in milk and brewing quality control. The advantage of FCM is that it can also differentiate viable nonculturable (VBNC) form of bacteria from healthy cultivable cells.[6] This technology has the ability to detect microorganisms at relatively low concentrations in a short time, whereas multiple labeling allows the detection of different organisms or different stages in the same sample.[6]

10.3.1.6 STEPS IN POLYMERASE CHAIN REACTION

The steps involved in polymerase chain reaction (PCR) are as follows:

- Isolation of DNA from the food
- Amplification of the target sequences
- Separation of the amplification products by agarose gel electrophoresis
- Estimation of their fragment size by comparison with a DNA molecular mass marker after staining with ethidium bromide
- Finally, a verification of the PCR results by specific cleavage of the amplification products and by restriction endonuclease or southern blot. Alternatively amplification products may be verified by direct sequencing or a second PCR.[9]

10.3.1.7 PULSED-FIELD GEL ELECTROPHORESIS (PFGE)

PFGE is a restriction-based typing method that is considered by many to be the "gold standard" molecular typing method for bacteria.[9] In this electrophoretic approach, DNA fragments are separated under conditions where there is incremental switch of the polarity of the electric field in the running apparatus. This technique allows for the resolution of DNA fragments up to 800 kb in size. When DNA is restricted with a restriction enzyme, PFGE provides a DNA "fingerprint" that reflects the DNA sequence of the entire bacterial genome. PFGE is a widely accepted method for comparing the genetic identity of bacteria.[9] PFGE typing has demonstrated a high level of reproducibility for foodborne pathogens. A major advantage of this method is its universal nature making it useful in bacteria subtyping; however, its limitation is that it is time-consuming.

10.3.1.8 MAGNETIC SEPARATION

Using this technique, investigators[15,20] separated salmonella from food and fecal matter using myeloma protein and hybrid antibody (for O antigen), conjugated to a polycarbonate-coated metal bead. It has also been reported that food sample like milk, yogurt, meat, and vegetables can be tested.[10] The challenge is in detecting *Escherichia coli* is in the isolation of pathogenic strain from nonpathogenic strains. Immunomagnetic detection of listeria monosytogens has also been investigated.[21]

10.3.1.9 NEAR-INFRARED SPECTROSCOPY

Near-infrared spectroscopy (NIR) has proven to be an effective analytical tool in the area of food quality control. The key advantages of NIR spectroscopy are: (1) its relatively high speed of analysis, (2) the lack of a need to carry out complex sample preparation or processing, (3) low cost, and (4) suitability for online process monitoring and quality control. The disadvantage of this method includes the requirement for large sample sets for subsequent multivariate analysis. Recently researchers at Zhejiang University in Hangzhou, China, used Vis/NIR spectroscopy together with multivariate analyses to classify nontransgenic and transgenic tomato leaves.[7,16,24]

10.3.1.10 X-RAY

This is a relatively newer technology in food quality control. X-rays started making inroads into the food industry in the early 1990s. The driving force behind this was the increasing number of foreign bodies which could not be identified by metal detectors. Other than contaminants such as glass, bone, rubber, stone or plastic, some specific applications are also more challenging for metal detectors, such as fresh meat and poultry, or foil-wrapped products.[5] X-ray inspection has considerable advantages in many foods and beverage-processing environments in that, it is easy to install, safe and simple to use, even without previous experience. It quickly and consistently identifies substandard products, reducing product recall, customer returns and complaints, therefore protecting manufacturers' brands and most importantly, preventing ill health.

10.3.1.11 COMPUTER VISION

Computer vision system consists of four basic components: the illumination source, an image acquisition device, the processing hardware, and suitable software modules.[3] The study was focused on analyzing the relevance of computer vision techniques for the food industry, mainly in Latin America. The authors described how the use of these techniques in the food industry eliminates the subjectivity of human visual inspection, adding accuracy, and consistency to the investigation. They also reported that the technique can provide fast identification and measurement of selected objects, classification into categories, and color analysis of food surfaces with high flexibility. They mentioned that since the method was noncontact and nondestructive, temporal changes in properties such as color and image texture can also be monitored and quantified.

10.3.2 FOOD QUALITY CONTROL: CASE STUDIES

10.3.2.1 LIVESTOCK

The meat and milk characteristics are more related with human health and with some factors affecting the quality.[4] The molecular biology techniques was of great interest to the researchers as these give insight to new product certification, namely, species, breed, animal category (age, sex, and so on.). Automatic milking systems (AMS) increases milk yield and milking frequency from twice to three times or more per day requiring a minimum extra amount of labor. However, contradictory results are reported about the effects of AMS on milk quality. Several authors found that after the introduction of AMS milk quality decreased, particularly fat, proteins percentage whereas total bacterial plate count, SCC, freezing point and the amount of free fatty acids were increased significantly.[4] The system consists of a highly general hardware setting, able to support different applications, and highly modular software, easily adapted to the measurement needs of diverse food products. The main result of this application was to classify rice grains and lentils.[3] Grain quality attributes are very important for all users and especially the milling and baking industries. Other study showed the usefulness of machine vision to identify different varieties of wheat and to discriminate wheat from nonwheat components.[25] Visible light photoluminescence (PL) peaking at around $\lambda=460$ nm is characteristic of cereals, such as rice, wheat, barley, millet, flour, corn starch, peanut, under illumination of ultraviolet light at $\lambda=365$ nm.[12] Authors further reported that peak intensity of PL and distribution of PL intensity varies with variety and source of the specimens, which was found to be fitted with a Gaussian curve. Visible light PL is suggested to be potentially useful technique for the nondestructive and quick evaluation of the cereals and other starchy products. The use of amperometric nanobiosensor for the determination of glyphosate and glufosinate residues in corn and soybean samples has been mentioned.[22] The biosensor has the features of high sensitivity, fast response time (10 to 20 s) and long-term stability at 40°C (>1 month). Detection limits were in the order of 10–10 to 10–11 M for standard solutions of herbicides and the spiked samples. The author found that herbicide analyses can be spiked on real samples of corn and soybean, corroborating that the biosensor is sensitive enough to detect herbicides in these matrices.

10.3.2.2 FRUITS, VEGETABLES, AND NUTS

Narendra et al.[17] observed that computer vision has been widely used for the quality inspection and grading of fruits and vegetables. It offers the potential to automate manual grading practices and thus to standardize techniques and eliminate tedious inspection tasks. The capabilities of digital image analysis technology to generate precise descriptive data on pictorial information have contributed to its more widespread and increased use. Method of PCR-SSCP has been used for the genetic differentiation of canned abalone and commercial gastropods in the Mexican retail market. The study was aimed at creating molecular tools that can differentiate abalone (*Haliotis* spp.), from other commercial fresh, frozen and canned gastropods based on 18S-rDNA and also identify specific abalone product at the species level using the lysine gene. It was found that the methods were reliable and useful for rapid identification of Mexican abalone products and could distinguish abalone at the species level. The methods could genetically identify raw, frozen and canned products and the approach could be used to certify authenticity of Mexican commercial products or identify commercial fraud.

Qualitative analysis of pesticide residues in fruits and vegetables has been conducted using fast, low-pressure gas chromatography—time of flight (ToF) mass spectrometry (LP-GC/MS).[14] It was demonstrated that, to increase the speed of analysis for GC-amenable residues in various foods and provide more advantages over the 40 traditional GC-MS approach, LPGC/MS on a ToF instrument should be applied as it provides high sample throughput with <10 min analysis time. The method had already been validated to be acceptable quantitatively for nearly 150 pesticides, and in this study of qualitative performance, 90 samples in total of strawberry, tomato, potato, orange, and lettuce extracts were analyzed. The extracts were randomly spiked with different pesticides at different levels, both unknown to the analyst, in the different matrices. Researchers compared automated software evaluation with human assessments in terms of false positive and negative results only to find that the result was not significantly different. Other investigated methods are robust ten-plex quantitative and sensitive ligation-dependent probe amplification method, the allergen-multiplex, quantitative ligation-dependent probe amplification (MLPA) method, for specific detection of eight allergens: sesame, soy, hazelnut, peanut, lupine, gluten, mustard, and celery. Ligated probes were amplified by PCR and amplicons were detected using capillary electrophoresis. Quantitative results were obtained by comparing signals with an internal positive control. The limit of detection varied from approximately 5–400 gene copies depending on the allergen. The method was tested using different foods spiked with mustard, celery, soy or lupine flour in the 1 to 0.001% range. Depending on the allergen, sensitivities were similar or better than those obtained with PCR.

10.4 CONCLUSIONS

Foods are the substances which provide nutritional support for the body. It may be of plant or animal origin, containing the known five essential nutrients, namely, carbohydrates, fats, proteins, vitamins, and minerals. These analytical procedures are used to provide information about a wide variety of different characteristics of foods, including their composition, structure, physicochemical properties, phytochemical properties, and sensory attributes.

Quality control is the maintenance of quality at levels and tolerance limits acceptable to the buyer while minimizing the cost for the vendor. Scientifically, quality control of food refers to the utilization of technological, physical, chemical, microbiological, nutritional and sensory parameters to achieve the wholesome food. These quality factors depend on specific attributes such as sensory properties, based on flavor, color, aroma, taste, texture and quantitative properties, namely, percentage of sugar, protein, fiber and so on as well as hidden attributes likes peroxides, free fatty acids.

The growth of diagnostic industry should result in increased rapid tests in the nearest future and this should result in improved performance. It is expected that, there will be significant economic benefits and the ability to practice proactive and risk prevention food safety programs, by 2015, the companies should be able to utilize automation technology to screen incoming raw materials and in-process parameters with near real-time information; physical, chemical or biological, while utilizing these newer methods.

It is therefore safe to conclude that food analysis and quality control is an indispensable tool in the food industry. As enumerated above, the development of adequate, effective, rapid, and sensitive food quality control systems however, faces serious challenges driven by its capital intensive nature and sophisticated adulteration. While it may seem easier for the developed nations to match quality control with adulteration techniques, to make any meaningful progress in resource-limited nations of the world, there is the need for collaborations between laboratories around the globe, just as it is necessary for regulatory agencies around the world to also collaborate both in sharing information and in technologies as well as capacity development.

Although some of these automated newer technologies are extremely rapid, there have been questions about their sensitivity. Some investigators agree that the instruments can produce results in seconds, but they opine strongly that they are not sensitive enough. In the nearest future, the mass spectrometry may be needed in food quality control. DNA-based assays, instruments, and software, all are designed to work together including the emerging area of bioinformatics; sequencing, assay design, and chemical analysis are all capable of developing new ways for food quality control in the future.

10.5 SUMMARY

Food analysis and quality control have many attributes and most of them have been mentioned in this chapter. Different food analysis methods are discussed, that is, physicochemical, phytochemical and packaging methods. Instrumental methods are also discussed in this chapter. Different types of quality control methods are also discussed to maintain the quality of food products. Food analysis and quality control processes are compulsory for all types of food industry.

KEYWORDS

- **Antioxidant**
- **ascorbic acid**
- **biosensors**
- **fiber**
- **food analysis**
- **food quality**
- **food technology**
- **gas chromatography**
- **good manufacturing practices**
- **nondestructive**
- **phenol**
- **physicochemical**
- **phytochemical**
- **protein**

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CHAPTER 11

INTERVENTIONS OF OHMIC HEATING TECHNOLOGY IN FOODS

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