Paper No. : 11

Paper Title: Food Analysis and Quality Control

Module - 01: Importance and Scope of Food Analysis and Quality Control

1.1 Introduction

Food analysis is the discipline dealing with the development, application and study of analytical procedures for characterizing the properties of foods and their constituents. By analysis, information about the different characteristics of foods, including their composition, structure, physicochemical properties and sensory attributes can be obtained. Food quality refers to the characteristics of food that is desirable and acceptable to consumers. It can be physical, chemical or sensory. Quality control is not an option in food processing. Every batch of food produced by a company should have achieved the quality standards set by it. Quality should always be consistent.

1.2 Food Analysis - Need and importance

All food products require analysis at various stages right from reception of raw materials through production and sometimes even after the product reaches the market. Food is analysed by government agencies, food industries and researchers for various needs and reasons which are discussed below.

1.2.1 Food Safety

The first and foremost reason for food analysis is to ensure its safety. A customer first expects his food to be safe. Food safety testing has become very essential as more and more contamination scares arise. Melamine in milk products, carbendazim in orange juice, fish tainted with PCBs (polychlorinated biphenyl), mercury-tainted milk powder and food supplements containing unauthorized food ingredients are a few of the recent contamination alerts across the world. Application of appropriate quality control procedures during analysis is necessary to ensure safe products from "farm to fork."

A food may be unsafe due to the presence of three different types of hazards namely

i. Biological hazard - harmful microbes (*e.g.*, Listeria, Salmonella)
ii. Chemical hazard - toxic chemicals (*e.g.*, pesticides, herbicides)
iii. Physical hazard - extraneous matter (*e.g.*, glass, wood, metal, insect matter).

It is the responsibility of the manufacturer to ensure that harmful substances are not present in the food he produces. This can be achieved by following good manufacturing practices, sticking to regulations specified by the government for specific food products and by having analytical techniques that are reliable and capable of detecting harmful substances.

Figure 1.1 Safe food through HACCP
(Source: www.foodsafetymagazine.com)

Many food industries try to achieve food safety by implementing systematic quality programs like Hazard Analysis and Critical Control Point (HACCP) which identifies specific hazards and their control measures. It focuses on prevention rather than relying mainly on end-product testing. Figure 1.1 shows the prerequisites for implementing HACCP program and achieving safe food. Food manufacturers and government laboratories routinely analyze food products to ensure that they do not contain harmful substances and that the food production facility is operating correctly.

1.2.2 Ensuring quality

The food industry sector has become highly competitive as consumers and buyers are becoming more aware of the importance of safe, high quality products. It has led to companies emphasising the quality of their products. In order to do this, a food industry needs to apply analytical methods across the entire food supply chain, from the raw ingredients to the final product. For e.g. when a consumer lodges complaint about a specific characteristic of a product, it is the responsibility of the manufacturer to perform analysis on the complaint sample and identify the problem pertaining to it. At the same time, it also helps the manufacturer to rectify the same in future. The following table shows the various areas and situations where analysis is required in a food industry.

Table 1.1 Types of Samples Analyzed in a Quality Assurance Program for Food Products

Sample Type	**Critical Questions**
Raw materials	Do they meet your specifications? Do they meet required legal specifications? Will a processing parameter have to be modified because of any change in the composition of raw materials? Are the quality and composition the same as for previous deliveries? How does the material from a potential new supplier compare to that from the current supplier?
Process control sample	Did a specific processing step result in a product control of acceptable composition or characteristics? Does a further processing step need to be modified to obtain a final product of acceptable quality?
Finished product sample	Does it meet the legal requirements? What is the nutritive value, so that label information can be developed? Or is the nutritive value as specified on an existing label? Does it meet product claim requirements (e.g., "low fat")? Will it be acceptable to the consumer? Will it have the appropriate shelf life?
Competitor's sample	What are its composition and characteristics? How can we use this information to develop new products?
Complaint sample	How do the composition and characteristics of a sample complaint sample submitted by a customer differ from a sample with no problems?

Adapted From: SS Nielsen, ed. Food Analysis, 3rd ed. New York: Kluwer Academic, 2003

1.2.3 Pricing

In many cases, the price of the product is directly linked with the quality. For e.g., a milk processor pays the producer based on the fat content of the raw milk. The percentage of sugar in the cane determines its price in sugar industries. There is difference in price of a pack of local coffee beans and that from a specific part of the world. Also there exists a difference in the price of sugar free sweets from that of the normal ones. Only analysis helps in confirming that the manufacturer is authentic.

A survey in Addis Ababa, Ethiopia, in 2012 showed that high quality products are sold at high prices in modern retail outlets. Also consumers are willing to pay higher price for high

quality products. A survey in 2010 showed that 72% of respondents from USA were more concerned with the quality of the food they're buying than the price. Additionally, nine out of ten said that they value nutrition of the food as well along with the quality.

1.2.4 Regulations

Food industries are subject to particularly strict regulations on the quality and safety of their products which is not without reason. If contaminated food reaches the retail market, the consequences can be serious. With the growing concerns about the food & health safety, the food regulatory authorities have imposed stringent mandatory norms for the presence of various toxicants, which if present beyond a prescribed residual level might prove hazardous to human health. It is important that all food products for trade within and export out of the country should meet the regulatory norms of the prescribed limits of different toxicants in various food products.

The food product's compliance with the standards does not hold good only for safety issues. There are certain regulations for deciding the identity of the product i.e., 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. Toned milk should have not less than 3% of fat and 8.5% SNF while double toned milk should have fat not less than 1.5% and 9% SNF (solids not fat).

In India also, The Food Safety and Standards Authority of India (FSSAI) has been established under Food Safety and Standards Act, 2006 which consolidates various acts & orders that have hitherto handled food related issues in various Ministries and Departments. FSSAI has been created for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food for human consumption.

1.2.5 Nutritional labelling

Nutrition labelling is mandatory in India. One of the major reasons for introducing this was to help consumers make informed choices about their diet. A recent internet based survey by Nielsen Company in 51 countries found that about 71% of Indians take notice of packaged goods' labels containing nutritional information and 59% of Indians mostly understand the nutritional panels and labels. With 59%, India also tops Asia-Pacific in its understanding of nutritional labels. As per the mandatory labelling regulation all processed food and beverage makers need to declare ingredients, weight, total calories (energy value), amount of protein, carbohydrate, fat, sodium (salt), sugars, dietary fibre, vitamins, minerals and amount of trans fats in their product labels. Proper analytical techniques have to be adopted by the manufacturers to give accurate information regarding the products' nutrition.

1.2.6 Detection of adulteration

Adulteration is defined as the addition or subtraction of any substance to or from food, so that the natural composition and quality of food substance is affected. It is alarming to know that about 25-30% of edibles sold in the market in India are intentionally adulterated. In 2012, a study in India conducted by the Food Safety Standards Authority of India (FSSAI) across 33 states found that milk in India is adulterated with detergent, fat and even urea, as well diluted with water. Out of the 1791 random samples from 33 states, just 31.5% of the samples tested (565) conformed to the FSSAI standards while the rest 1226 (68.4%) failed the test. This indicates the role of food analysis in detecting food adulteration.

1.2.7 Characterisation of raw materials

Companies increasingly rely on select suppliers to supply high-quality, safe raw ingredients and packaging materials. These suppliers perform analytical tests to ensure compliance with

specifications for raw materials. Results of these analytical tests related to the predetermined specifications are delivered as a Certificate of Analysis (COA) with the raw material. Companies must have means to control and monitor these COAs. With careful control over the quality of raw materials, less testing is required during processing and on the final product.

Some companies perform their own tests on the raw materials received. If the lot does not meet their standards then it is rejected. Variations in the properties of raw materials might lead to changes in the properties of the final product. By analyzing the raw materials it is often possible to predict their subsequent behaviour during processing so that the processing conditions can be altered to produce a final product with the desired properties. For example, the colour of potato chips depends on the concentration of reducing sugars in the potatoes used for production. Higher the concentration of reducing sugars, browner the potato chip. Thus by analytically measuring the concentration of reducing sugars in the potatoes the frying conditions can be altered to produce the optimum coloured potato chip.

1.2.8 Monitoring during processing

Monitoring the food product at certain stages during processing is advantageous as it can help eliminate any deviations from the actual product quality. If such testing is done during processing, corrective measures can be taken at the right time which prevents the rejection of the entire lot of products. For e.g. In the case of biscuits with peanut, it is required to know that the biscuits have correct shape and also if there is a peanut of required size in the centre of the biscuit. Biscuits without peanuts and those with incorrectly located peanuts have to be rejected. Also the specific line which misplaces peanuts has to be corrected to adjust the peanut's position. This can be done by image processing and analysis during processing. Fig 1.2 shows the actual picture of the biscuits on the left. The one on the right shows red and green colour to indicate the rejected and acceptable biscuits.

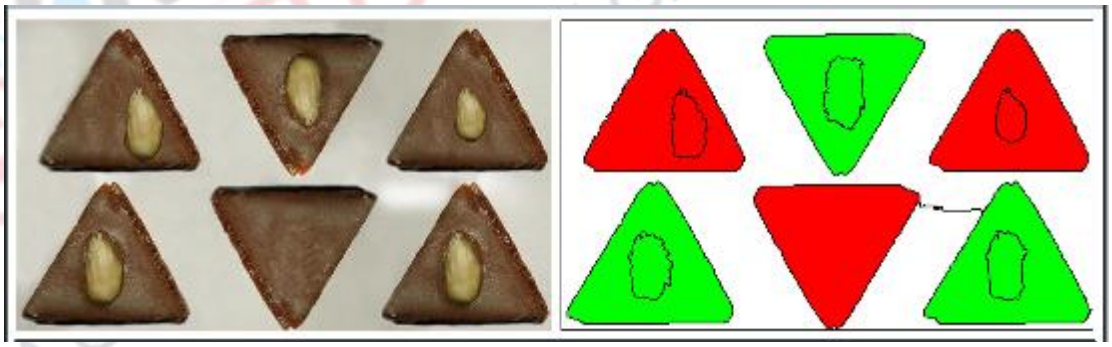

Fig 1.2 Monitoring the shape and peanut position and size during processing
(Source: www. burgsys.com)

Also, the taste and crispiness of the biscuits can be found out by sensory and texture analysis. All these analyses can help monitoring the quality of biscuits during processing.

1.2.9 Final product characterisation

Testing the final product will ensure that the product meets the necessary quality standards, labelling requirements and government regulations.

1.2.10 Research and Development

Various scientists and researchers throughout the world are continuously analysing food materials for better understanding of their properties so that improvement can be done during their processing. Their research is mainly directed towards investigating the structure and interaction of food ingredients, and how they are affected by changes in temperature, pressure and mechanical agitation. Scientists working for food companies are usually involved in

product development. These scientists help improve existing products or develop new products.

1.3 Steps in Food Analysis

Analysis of foods generally involves three main steps namely

1) Selecting and preparing the sample:
   Collecting the sample and preparing it for analysis is more difficult and important due to the non-homogeneity of food and uneven distribution of certain constituents. Hence collecting a representative sample itself becomes a challenge. Conditions of sample preparation and the instability of certain food constituents make it difficult to ensure that the composition and characteristics of the sample collected are identical to those of the sample subjected to the analytical test.

2) Performing the analysis:
   Each food component or characteristic to be tested may require a specific method or technique for analysis. There are several techniques for analysis like physical, chemical, textural, spectroscopic, chromatographic, polarimetric, refractometric and thermal methods. Selecting the right technique is very essential to get reliable results. Selection of the analytical technique mainly depends on the objective of measurement. For e.g., methods or techniques for online processing measurements must be rapid. But they are less accurate than the methods used for nutritional labelling.
   Also it must also be taken care that the glassware and other lab ware used must be clean and equipment properly checked and calibrated.

3) Calculating and interpreting the results:
   The results obtained from performing the analysis of food components and characteristics are utilized to make decisions and take further action on any issues, if any. The analytical data obtained can be evaluated and integrated with other relevant information to address food quality-related problems. These data are critical not only for quality assurance, but also in product formulation and process design.

1.4 Food analysis and Quality control

Quality control includes evaluating an activity, a product, process, or service to determine if the end product results are satisfactory or not. Quality control in a food processing system begins right from the stage of food production till the stage of its sale and distribution.

i. Production stage:

During the production stage, the use of pesticides, fertilizers for plant foods and veterinary drugs and hormones for animals must be controlled. Also quality is very important during harvesting and storage of the harvested product.

ii. Processing stage:

During the processing stage, use of HACCP approach and good manufacturing practices (GMP) can ensure quality.

iii. Distribution stage:

Improper distribution of products also affects the quality of finished product. The conditions of transportation and storage of food like temperature, humidity etc. is very important. Care should be taken by the retailer to see that food is not held beyond its shelf life. Protection against insects, rodents, and extraneous matter is also essential.

At each of the stages mentioned above, analysis of food becomes inevitable in order to ensure and control its quality. Hence both food analysis and quality control are inseparable.

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