Food Analysis & Quality Control

Vedpal Yadav

FAQC- Syllabus- RATIONALE

- In the production of processed foods, one of the important aspects is to assure quality. This subject is introduced in the curriculum to impart knowledge and skills in the students related to various food quality parameters/systems, techniques of food analysis, food laws and standards.

FAQC- Syllabus-Theory

1. Introduction (4 hrs)
   Concept, objectives and need of quality, quality control and quality assurance

2. Principles and functions of quality control, quality attributes - qualitative, hidden and sensory, plan and methods of quality control (10 hrs)

3. Sampling (6 hrs)
   Definition of sampling, purpose, sampling techniques requirements and sampling procedures for liquid, powdered and granular materials

4. Physicochemical and mechanical properties (10 hrs)
   Colour, gloss, flavour, consistency, viscosity, texture and their relationship with food quality

5. Sensory quality control (12 hrs)
   Definition, objectives, panel selection and their training, subjective and objective methods, interpretation of sensory results in statistical quality control, TQM and TQC, consumer preferences and acceptance

6. Food Laws and Regulations in India (8 hrs)
   Objectives, requirements and benefits of food grades and standards (BIS, AGMARK, PFA, FPO, CAC (Codex Alimentarius Commission))

7. General Hygiene and Sanitation in food industry (4 hrs)
FAQC- Syllabus-Theory

8. GMP, HACCP (Hazard analysis and critical control point) and ISO 9000 Series – Objectives and principles (6 hrs)
9. Layout of quality evaluation and control laboratories (4 hrs)

FAQC- Syllabus-Practical

1. Proximate analysis of marketed food products
2. Detection of adulteration in food products viz. milk, ghee, honey, spices, pulses, oils, sweets etc.
3. Detection of non-permitted food additives in market food samples, sweets and savory products
4. Cut-out analysis of canned food

FAQC- Syllabus-Practical

5. Test of sensory evaluation
   a) Hedonic scale
   b) Duo-trio test
   c) Ranking difference
   d) Triangle test
6. Detection of basic tastes and their threshold values
7. Consumer acceptability trial
8. Statistical analysis of sensory data

Food Analysis

- What do we mean by “food analysis”? 
- How do we approach the analysis of foods?

Food Analysis

- Proximate analysis of major components
  - fat, moisture, protein
- Minor nutrients
  - vitamins, minerals, etc.
- Trace components
  - preservatives, flavours, colours
- Contaminants
  - pesticide residues, aflatoxins, heavy metals
Food Analysis

- Detailed compositional analysis
  - protein composition
  - amino acid composition
  - lipids (fatty acids and triglycerides)
  - sugar composition

Levels of Food Components

- Major components > 10%
- Minor nutrients 1% - 0.01%
- Preservatives 100 - 500 ppm
- Flavours 1 - 10^-6 ppm
- Contaminants
  - pesticide residues < 1 ppm
  - aflatoxins 10^-9 ppm

Why instrumental analysis?

- Demand for more detailed analyses at lower levels
- Need for precision and accuracy
- Public concern about quality of environment and food
  - regulatory bodies must monitor large range of materials
  - river water - processed foods
- Medical diagnosis
  - detection and quantification in biological fluids
- Cost

Selection Criteria

- Precision and accuracy
  - objective vs. subjective measurements
  - variability
  - specificity
  - validity against existing methods
- Speed of analysis
  - analytical time and operator time
  - preparation of sample for analysis
- Cost
  - consumables, equipment, staff
- Safety
- Automation

Analytical Approach

Food Analysis & Quality Control

- Analysis of foods and their components
- Principles and application of instrumental analysis
  - chromatography
  - electrophoresis
  - UV-visible, fluorescence and atomic absorption spectrophotometry
- Practical classes to illustrate the use of instrumental methods for food analysis
  - Selected topics related to food ingredients, additives and contaminants
Separation Techniques in Food Analysis

- What do we mean by “food analysis”?
- How do we approach the analysis of foods?
- What techniques are available?
  - separation techniques
  - non-separation techniques

Food Analysis

- Proximate analysis of major components
  - fat, moisture, protein
- Minor nutrients
  - vitamins, minerals, etc.
- Trace components
  - preservatives, flavours, colours
- Contaminants
  - pesticide residues, aflatoxins, heavy metals

Food Analysis

- Detailed compositional analysis
  - protein composition
  - amino acid composition
  - lipids (fatty acids and triglycerides)
  - sugar composition

Levels of Food Components

- Major components > 10%
- Minor nutrients 1% - 0.01%
- Preservatives 100 - 500 ppm
- Flavours 1 - 10^-8 ppm
- Contaminants
  - pesticide residues < 1 ppm
  - aflatoxins 10^-3 ppm

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- Public concern about quality of environment and food
  - regulatory bodies must monitor large range of materials
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Selection Criteria

- Precision and accuracy
  - objective vs. subjective measurements
- Variability
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- Speed of analysis
  - analytical time and operator time
  - preparation of sample for analysis
- Cost
  - consumables, equipment, staff
- Safety
- Automation
Analytical Approach

- Food
- Representative Sample
- Sampling
- Extraction
- Extract
- Clean-up
- Cleaned Extract
- Separation
- Components of Interest
- Identification of Components
- Quantification of Individual Components

Quality

- It is the combination of attributes or characteristics of a product that have significance in determining the degree of acceptability of the product to a user (USDA Marketing Workshop Report, 1951).

Quality

- People go through a process of inspection to assure that the "Quality" of what they are purchasing meets their definition of quality (measures up to their standards).
- The buyer or consumer gets the satisfaction for having paid the correct competitive price for the similar quality.

Quality

- In the absence of detailed methodology the reproducibility of the results suffers.
- Consequently there is an absolute need of food analysts at
  - operative and supervisory-level,
  - food manufacturers
  - processing technologists,
  - advocates and
  - judges handling court cases about quality disputes,
  - students of analytical chemistry and food technology.

Quality

- The manufacturers and their manufacturing personnel also need to know the precise quality of the raw materials they are starting with, the quality of the intermediates formed so that through corrective steps the final product of the desired quality is obtained.

Quality

- Quality can be defined as a measure of purity, strength, flavor, color, size, workmanship, and condition, and or any other distinctive attribute or characteristic of the product (Gould and Gould, 1988).
- Quality must be defined in terms of some standard/specification, or it means very little.
- Quality = finest product available. Conformance to design/expectations.
- Quality is the degree of excellence and uniformity of a food as measured by various factors/attributes/characteristics against a standard.
- Quality has different meanings to different people.
Quality

- Countries where food is abundant, people choose foods based on a number of factors which can in sum be thought of as "quality."
- **Quality has been defined as degree of excellence and includes such things as taste, appearance, and nutritional content.**
- We might also say that quality is the composite of characteristics that have significance and make for acceptability.

Acceptability, however, can be highly subjective.

- Quality and price need not go together, but food manufacturers know that they generally can get a higher price for or can sell a larger quantity of products with superior quality.
- Often "value" is thought of as a composite of cost and quality. More expensive foods can be a good value if their quality is very high.

Food Safety Assurance

- What is ‘safe’ food? invokes different answers depending upon who is asked. Essentially the different definitions would be given depending upon what constitutes a significant risk.
- The general public might consider that 'safe food' means zero risk.
- Unfortunately there is no public consensus on what constitutes an acceptable risk.
- A difficulty that arises in manufacturing ‘safe’ food is that the consumer is a mixed population with varying degrees of susceptibility and general life style.
- The consumer pressure is for greater varieties of fresh and minimally processed foods, natural preservatives with a guarantee of absolute safety.

The manufacture of hygienic food

- The production of safe food requires (CAC ALINORM 97/13, Codex Alimentarius Commission 1995):
  - Control at source
  - Product design and process control
  - Good hygienic practice during production, processing, handling and distribution, storage, sale, preparation and use.
  - A preventative approach because effectiveness of microbial end-product testing is limited.

Quality control (QC) is not an optional extra in food processing; neither is it something that is only done by large manufacturers.
- It is an essential component of any food processing business.
- The purposes of quality control are:
  - To protect the customers from dangers (eg contaminated foods) and ensure that they get the weight and quality of food that they pay for.
  - To protect the business from cheating by suppliers, damage to equipment (eg stones in raw materials) and false accusations by middlemen, customers or suppliers.
  - To be sure that food laws operating in a country are complied with.
QUALITY CONTROL IN FOOD PROCESSING BUSINESSES

- Quality control need not be time consuming or expensive and the results of quality control tests should help save money in the long run.
- In general, the quality control procedures used should be as simple as possible and only give the required amount of information (too little information means the test has not done its job, too much information and management decisions may be delayed or confused).

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Quality specifications

- The quality of foods or ingredients can be measured in different ways but one popular method is to describe ‘quality attributes.’
- A specification can then be written and agreed with the supplier or seller, which lists the quality attributes that are required in a food.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Accept</th>
<th>Reject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Orange/red</td>
<td>More than 10% green</td>
</tr>
<tr>
<td>Size</td>
<td>Any</td>
<td>-</td>
</tr>
<tr>
<td>Shape</td>
<td>Any</td>
<td>-</td>
</tr>
<tr>
<td>Damage - splitting</td>
<td>Less than 5%</td>
<td>More than 5%</td>
</tr>
<tr>
<td>- insect</td>
<td>Less than 5%</td>
<td>More than 5%</td>
</tr>
<tr>
<td>- mould</td>
<td>None</td>
<td>Any evidence of mould</td>
</tr>
<tr>
<td>Hardness</td>
<td>Soft to oversoft</td>
<td>More than 10% hard</td>
</tr>
</tbody>
</table>

Quality specifications

A number of points arise from such a specification:

- A representative sample of the food must be tested to make sure the whole batch meets the specification (for small batches it might be possible to examine every item). The size of sample needed for testing can be calculated, but this is fairly complex and usually unnecessary for a small-scale business.
- The percentage of substandard items which cause a batch to fail the test can be increased or decreased depending on how reliable the supplier is or how important the particular attribute is to the seller/manufacturer.
- Some attributes may need to be tested using equipment to avoid arguments over interpretation. In Figure 1 the hardness could be tested with a simple ‘penetrometer’ to define what is ‘hard’ and what is ‘soft.’
Quality specifications

- The size and shape of the tomatoes is not important because they are to be crushed to a pulp.
- In other examples (eg fruit for bottling) the size might be important.
- The ripeness and flavour of the tomatoes (assessed by colour and hardness) and damage caused by poor storage and handling are very important and the specification concentrates on these.
- Each specification takes account of the intended use of the products and the likely important faults that could be expected.

Quality specifications

<table>
<thead>
<tr>
<th>Quality attribute</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative</td>
<td>6</td>
</tr>
<tr>
<td>Hidden</td>
<td>Aflatoxin in groundnuts</td>
</tr>
<tr>
<td>Harmful substances</td>
<td>Number of bacteria in a food</td>
</tr>
<tr>
<td>Microbiological</td>
<td>Vitamin content of a food</td>
</tr>
<tr>
<td>Nutritive value</td>
<td>Artificial flavours, thickeners etc</td>
</tr>
<tr>
<td>Additives</td>
<td>Ripeness of fruit</td>
</tr>
<tr>
<td>Sensory</td>
<td>Size of chopped food, particle size of</td>
</tr>
<tr>
<td>Colour</td>
<td>Juice consistency, toughness of meat</td>
</tr>
<tr>
<td>Size, shape (appearance)</td>
<td>Saltiness, sweetness, sourness and</td>
</tr>
<tr>
<td>flour</td>
<td>Characteristic flavour of tomato</td>
</tr>
<tr>
<td>Thickness or texture</td>
<td></td>
</tr>
<tr>
<td>Taste</td>
<td></td>
</tr>
<tr>
<td>bitterness</td>
<td></td>
</tr>
<tr>
<td>Flavour</td>
<td></td>
</tr>
</tbody>
</table>

Control points

- In every food process there are particular stages which affect the quality of the final product (eg the amount of heating given to pasteurised juices affects the colour, flavour and storage life or in sausage the amount and type of grinding affects the texture of the meat).
- These stages are identified as control points and quality control checks are made at these points to control the process.
- Manufacturers therefore need to identify the control points in their process (using outside technical assistance if necessary) and set up a specification for the operators to use.

Control points

- For example, in jam making the amount of pectin, fruit and sugar should be carefully controlled and weighing of ingredients is a control point (weights of each ingredient specified and each carefully weighed out).
- Likewise the acidity of the jam, the sugar content after boiling and the temperature of filling are each control points.
- The mix should be checked for correct acidity, the sugar content checked during boiling using a thermometer or refractometer and the temperature checked before filling using a thermometer.
- Checks at the control points can therefore be used to control the process and ensure that each batch of product has a similar quality.

Quality Assurance- A Model Program for the Food Industry

- The dictionary defines quality as an important character, a degree of excellence or a necessary attribute.
- A group of activities designed to assure a standard of excellence is called Quality Control.
- Quality or excellence in our food supply should be an important concern to all food processors.
- Safety and wholesomeness are the most important attributes of food quality.
- The lack of quality as it relates to safety and wholesomeness can result in personal injury, sick­ness or death.
- Food-borne illness is an example of sickness or even death when unsafe foods are produced and eaten.

Quality Assurance- A Model Program for the Food Industry

- Certain foods or food products are defined by regulations or policies called standards of identity.
- These standards of identity are definitions for a specific food product to avoid confusion or mislabeling of similar processed foods.
- Milk is a good example.
- The standard for skim milk is less than 1/2 percent fat, while the standard for whole milk is at least 3-1/4 percent fat.
Quality Assurance-
A Model Program for the Food Industry

- Quality defined by regulations, policies or standards is controlled by federal and state agencies.
- Failure to meet the degree of excellence defined by the regulations, policies or standards of identity is illegal.
- The government-controlled attributes of food are another important measure of food quality.
- Therefore, the first category of food quality is critical attributes and includes factors that affect safety, wholesomeness or legality.

Besides the critical attribute of safety, other properties of the food product should be used to define overall quality.

- These other attributes are defined by industry, the processor or consumer demand.
- An example of this is the particle size of flour, the shape of a frankfurter or sausage or the color and flavor of salad dressing.
- Two other categories that classify or describe additional quality characteristics of food products are called major and minor attributes.

A major attribute is determined to be necessary for the food but not essential from a safety and legal standpoint.

- A major attribute could be fat content of hamburger meat or the portion weight of green peas in a frozen prepared dinner.

A minor attribute is wanted but not absolutely essential to the product or not easily determined.

- For instance, the desirable flavor properties of foods are highly subjective (dependent upon people), not easily measured and should be a minor attribute.
- However, flavor defects that can reduce sales should be classified in the major category.

The critical, major and minor attributes usually describe the key chemical, physical, and microbiological properties of a food.

- The manufacturing process and many known or unknown factors will affect the finished product.
- Therefore, a control program is the tool for the food processor to use to assure that quality targets are met.

Finally, to develop a quality control program, you must define expected food quality provide a system of quality measurement, allow a means for action not reaction, help to minimize costly errors, and reduce the risk of food safety and wholesomeness defects.

- What is needed for a quality control program?
  - The first step is a strong commitment from management. Quality control must have the same priority as the profit and loss statement for the business.
Quality Assurance - A Model Program for the Food Industry

Quality doesn't cost, it pays. Beyond commitment, management must instill quality awareness throughout the organizational structure.

- A successful quality program needs people.
- It is important that the food operation personnel function as a team and openly communicate to identify problems, issues or opportunities.
- Once key elements of a quality control program are in place (management commitment, quality awareness, a team effort and open communication), develop and use additional tools.

The basic tools of quality control are:

- Ingredient Specifications
- Approved Supplier List
- Product Formulas
- Product Standards (Specifications)
- Manufacturing Procedures

The quality of the finished food product after manufacture depends on the quality of the raw materials and ingredients.

- The best starting point for developing ingredient specifications is the supplier.
- Ask for a copy of the supplier's ingredient specifications.
- Review the information and modify the specifications to your needs.
- Discuss and settle specifications with the supplier.
- At times, specifications need to be negotiated with suppliers.
- Custom specifications from suppliers are possible.
- The ingredient specifications should be documented in a form consistent with the processor’s needs.

The prepared ingredient specifications become a tool for control.

- The information under each heading should be simple but informative.
- Figure 2 is an example of an ingredient specification. It is simple and informative.
- The basic description is short and to the point.
- Critical specifications include two items associated with public safety.
Quality Assurance - A Model Program for the Food Industry

Critical specifications can also include factors influencing wholesomeness or legality.
Action levels are used as a reference point to identify a potential problem.
If the ingredient consistently reaches action levels, notify your supplier.
The reject level is the point of refusing delivery of the ingredient.
The ingredient statement for the raw material is a reference point to assure that the supplier has not changed the material.
The final key point for ingredient specifications is for the supplier to know and agree to the content of the document.

GROUND BLACK PEPPER

CODE NUMBER: A-001
PRODUCT DESCRIPTION: Ground black pepper shall be prepared from the dried, immature berries of **Piper nigrum**. The color can vary from light-gray to a speckled black-gray.
EFFECTIVE DATE: Today’s date
CRITICAL SPECIFICATIONS:

<table>
<thead>
<tr>
<th></th>
<th>Action Level</th>
<th>Reject Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella</td>
<td>none</td>
<td>Positive at 100</td>
</tr>
<tr>
<td>E. Coli</td>
<td>none</td>
<td>Positive</td>
</tr>
</tbody>
</table>

MAJOR SPECIFICATIONS:

<table>
<thead>
<tr>
<th></th>
<th>Action Level</th>
<th>Reject Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granulation</td>
<td>4.5%</td>
<td>&gt;5% (retained on a U.S. #35 sieve)</td>
</tr>
<tr>
<td>Volatile Oil</td>
<td>2.0%</td>
<td>&lt;2%</td>
</tr>
<tr>
<td>Moisture</td>
<td>11.5%</td>
<td>&gt;12%</td>
</tr>
<tr>
<td>Color</td>
<td>Light-gray to black-gray</td>
<td>off-white to light gray</td>
</tr>
<tr>
<td>Yeast/Mold</td>
<td>&lt;100 per gram</td>
<td>&gt;100 per gram</td>
</tr>
</tbody>
</table>

MINOR SPECIFICATIONS: None

INGREDIENT STATEMENT: Ground Black Pepper

Figure 2. An Ingredient Specification Document

Approved Supplier List

For each ingredient, an approved supplier list should exist and be available to individuals responsible for purchasing and quality control.
In theory, more than one supplier per ingredient is desirable.
A good target is three suppliers per ingredient.
A supplier is an ingredient manufacturer, a broker or a distributor.
When necessary, identify both the manufacturer and distributor on the approved supplier list.

Product Formulation/Recipe

Proprietary formulas are important.
For each food product, written documentation of the formula or recipe should exist and be available for use by selected individuals.
The formulas should be used daily as a means to assure consistency between batches, lots and even days of production. Manufacturing personnel need to know the recipe to assure that the product is formulated correctly.
For highly confidential formulas, the production worker does not need all the details.
A simplified recipe can be provided to assure that the secret stays a secret.
Quality Assurance—
A Model Program for the Food Industry

- The individual formula sheets can have a variety of formats. Key aspects of any formula document are:
  - Name of the product.
  - Internal code number.
  - Effective date.
  - Listing of the ingredients.
  - Listing of the ingredient code.
  - Percentage formula.
  - Batch formula.
  - Batch yield.
  - Ingredient statement.

Additional information that can be part of a formula document are packaging, lot size, regulatory constraints, net weight, package count per batch, etc.

Be flexible with the format since the formula may purposefully be modified and the kind of information needed may change.

If nothing else, the batch size may change due to business growth or decline.

Figure 3 is an example of a formula sheet.

---

CHILI WITHOUT BEANS
CODE NUMBER: B-001
EFFECTIVE DATE: Today’s date

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Code</th>
<th>% Formula</th>
<th>Batch Formula (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef, 77% lean</td>
<td>A-002</td>
<td>40.00</td>
<td>240.0</td>
</tr>
<tr>
<td>Tomato Puree, 32% T. S.</td>
<td>A-003</td>
<td>11.74</td>
<td>70.4</td>
</tr>
<tr>
<td>Addie</td>
<td>A-004</td>
<td>40.00</td>
<td>240.0</td>
</tr>
<tr>
<td>Spice Premix</td>
<td>C-001</td>
<td>3.83</td>
<td>23.6</td>
</tr>
<tr>
<td>Corn Starch</td>
<td>A-005</td>
<td>4.33</td>
<td>26.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100.0</td>
<td>600.0</td>
</tr>
<tr>
<td>Spice Premix</td>
<td>C-100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chili Powder</td>
<td>A-006</td>
<td>31.75</td>
<td>7 lb. 8 oz.</td>
</tr>
<tr>
<td>Salt</td>
<td>A-007</td>
<td>21.17</td>
<td>5 lb.</td>
</tr>
<tr>
<td>HVP</td>
<td>A-008</td>
<td>20.00</td>
<td>4 lb. 9 oz.</td>
</tr>
<tr>
<td>Sugar</td>
<td>A-009</td>
<td>12.70</td>
<td>3 lb.</td>
</tr>
<tr>
<td>Cumin, grounded</td>
<td>A-010</td>
<td>6.25</td>
<td>1 lb. 6 oz.</td>
</tr>
<tr>
<td>Onion powder</td>
<td>A-011</td>
<td>5.83</td>
<td>1 lb. 6 oz.</td>
</tr>
<tr>
<td>Oregano, grounded</td>
<td>C-012</td>
<td>2.37</td>
<td>6 oz.</td>
</tr>
<tr>
<td>Garlic Powder</td>
<td>A-013</td>
<td>0.75</td>
<td>3 oz.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100.08</td>
<td>23 bs. 19 oz.</td>
</tr>
</tbody>
</table>

Batch yield: 600 lbs.
Finished Product Yield: 595 lbs.


Figure 3. A Food Product Formula Document.

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Product Standards

- A key tool to assure quality in a finished processed food is the product standard document.
- Product standards define the food by physical, chemical and microbiological characteristics.
- Appearance, aroma, flavor and texture can and should also be considered for product standards.

Physical characteristics include size, shape, dimensions, weight, volume, count per package or container, presence of fines, or any other special features which define the particular food.

Moisture, fat, protein, ash, fiber and carbohydrates are the basic chemical characteristics.

Additional chemical criterion such as salt, sodium, cholesterol, etc., are used to chemically define food products.

Chemical standards are necessary when using nutritional labeling or making label claims for low sodium, higher fiber or other nutritional facts.

Microbiological standards will be dependent upon the specific food item.

First consider food poisoning organisms when developing product standards for a quality control program.

Food safety is the responsibility of the processor. If the food product will support the growth of a potential food poisoning organism, identify the particular organism in the critical standards category as opposed to a major or minor standard.

Some typical food poisoning organisms are Salmonella, Clostridium botulinum, Staphylococcus aureus and Clostridium perfringens.
Other microbiological standards such as a standard plate count (SPC), yeast or mold may be appropriate for classification as major or minor standards.

For many products, especially those subjected to cooking or other thermal processes, use *Coliforms* and *E. coli* analyses to show and control post process contamination of cooked foods.

Consider microorganisms that can cause food spoilage in a particular food product when establishing product standards.

Yeast and mold counts are essential to control programs involving food items with low or restricted moisture levels like flour or cereals.

A simple standard plate count is always a good general indicator for tracking bacterial quality and should be considered at least a minor criterion.

The sensory properties of a food product are keys to the consumer acceptance.

Flavor, texture, aroma and appearance are criterion that should be defined to assure that the product meets design expectations.

Qualitative measures of sensory properties can be costly due to requirements for sophisticated equipment.

Qualitative testing using taste panels, is an alternative to quantitative measurements.

Make a sensory evaluation for flavor, odor and texture a part of a quality control program.

Establish a reject level for each product standard along with acceptable methodology.

Base minimum reject levels upon regulatory requirements and practical production experience.

If a method of measurement is nonexistent, then the standard is nonexistent.

The last element to product standards is a simple statement of ingredients as it will appear on the label.

For each product, document the method of fabrication or processing procedures to ease duplication from lot to lot, shift to shift and day to day.

A simple way to approach this is a clear and concise "cookbook" approach.

Key steps in the process which can impact upon yield, quality or production efficiency should be highlighted.

Examples of key process steps might be "mix for 3 minutes before adding spices" or "cook to a minimum internal temperature of 145 degrees F."

Several key points to consider when identifying important processing operations are time, temperature, equipment required, order of addition for ingredients and weight.
Quality Assurance - A Model Program for the Food Industry

Manufacturing procedures also should include special instructions to the line worker or quality control personnel.
A example instruction could be, “cross check” the net weight of five packages every hour.
Figure 5 shows a simple manufacturing procedure to be used by production and quality control personnel.
Once prepared, make manufacturing procedures or portions of the procedures available to production employees.
Use the document as an employee training tool.
Even with the best procedures, employees will find a “better” way to manufacture the product.
Be open minded.
If the new way is better, use it; if not, explain why.
The key is for the employee to follow instructions.

In-Process Records

It is important to know what is happening with the product and process during manufacturing. In-process record keeping is a way of obtaining the information.
Both quality control and production personnel should participate in maintaining a daily manufacturing log.
The specific product weight, temperature, size and shape, ingredient usage, product yield, scrap or waste, material balance and rework are examples of measurements made during the manufacturing process.

Base the kinds of in-process measurements used in each operation upon what is called Critical Control Points.
A critical control point is a step in the process or in product formulation where small differences, changes or mistakes can cause the finished product to be a health hazard, illegal or costly to the business.
Critical control points are identifiable (Figure 6).
Some critical control points are defined by regulation when public health or product identity are of concern.
Cooking temperatures, pasteurization time and temperature or allowable levels of ingredients are processing variables oftentimes defined by regulation.

Critical control points may be self-imposed because of desired label statements on the part of the processor.
Net weight is one example while nutritional labeling is another.
The cost of a product can be increased by simple employee mistakes.
In this case, critical control points in processing simply relate to those processing steps that influence yield or inferior product.
In-process record keeping can be a manual or automatic operation and in some cases both.
Employee participation in record keeping provides an opportunity for pride in workmanship. In-process records also are a means of making adjustments to the product or process and preventing substandard product.

Turn in all in-process records to supervisory management for review at the end of a shift or working day.
The supervisory review allows an opportunity to identify problem areas and to make changes to prevent reoccurrence.
In some food processing operations, like a poultry or red meat facility, these records are available to the on-site USDA inspector.

Packaging and Labeling

A quality control program should include packaging and labeling.
One of the first items that influence the consumer is the appearance of the package and the label.
Two basic packages are typically necessary for food products.
The primary package encloses the food and has direct contact with the product.
A film, jar, bottle, carton or box are some of the common primary packages.
The secondary package is used to assemble multiple packaged food items for shipment.
Quality Assurance - A Model Program for the Food Industry

- The shipper or secondary package provides protection, reduces handling of each individual bottle or carton and is necessary for efficient movement of goods to the consumer.
- Some packaged foods, particularly microwaveable products, have three package components: the pouch, the carton and the shipping case.
- Poor packaging or labeling can create negative impressions relative to product quality.
- This is true for both simple and complex packages or labels.

Packaging serves to protect the food product and allows shipment of multiple units. Items for packaging consideration are:

- A statement from the supplier that the packaging is made of FDA and/or USDA approved materials. The package composition should be listed on the statement.
- Dimensions of carton, jar, bottle or box.
- Strength of the container and suitability for stacking, freezing or microwaving.
- Strength of seals or fit of the lid. For heat sealed packages, the temperature requirements for sealing are critical.

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Overall graphics must represent the contents of the container so mislabeling or misbranding does not occur.
- Some typical package and label defects are smears, scuffs, color variations, broken seals leaks, short fill and product infestation or spoil age.
- The defects can be found in both single unit packs and multi-packs (shippers).
- It is to a food processor's advantage to develop packaging and label specifications along the same format as ingredient specifications.

Materials of construction are particularly important where direct contact with the food is involved.
- Certain chemicals or foreign materials from packaging materials can contaminate the food product.
- The packaging material must meet FDA and/or USDA requirements. Use a reputable packaging supplier.
- The manufacturer of the package is the main source for package specifications.
- Local distributors can obtain the needed information from the manufacturer.
Quality Assurance -
A Model Program for the Food Industry

- Dimensions of the package, both inner and outer, are defined to prevent problems such as under or over-fill, shifting within the package, spillage or breakage of the container.
- Lack of control can be costly for product loss, giveaway or lost sales.
- The strength of the container and the seals or the fit of the lid are important considerations.
- Failure with regard to these items can result in crushing, breakage or spillage.
- Most important is the potential for physical or microbiological contamination when a poor seal of improperly fitting cap is a package defect.

An overview of GMPs

- Individuals with communicable diseases cannot work in areas where food contamination is possible.
- This includes individuals with boils, sores or infected wounds.

An overview of GMPs

- Food handlers must follow good personal hygiene practices.
  - Wear protective clothing.
  - Clean and sanitize hands and gloves.
  - No jewelry.
  - Use gloves (non-absorbent) when the job requires hand covering.
  - Use effective hair restraints and covering.
  - Eat, drink or smoke only in designated areas.

An overview of GMPs

- Train employees effectively in hygiene, sanitation and pest control.
- Along with GMPs, a cleaning and sanitizing program is essential.
- Cleaning and sanitizing should address three basic areas:
  1. Exterior facility and grounds.
  2. Internal facility including floors, walls, ceilings and ventilation system.
  3. Equipment and all food contact areas.

An overview of GMPs

- A cleaning and sanitizing program prevents the build up of dirt and debris, maintains equipment in good repair, prevents growth and contamination from microorganisms and prevents the entry and harboring of insects and other pests.
- The quality program should: outline specific activities to be performed, any corrective measures, and schedules for cleaning and sanitizing, identify approved cleaning compounds, sanitizers and baits and define a standard. Keep and maintain proper records.
Warehousing

- Warehousing involves three activities (receiving, storage and shipping) that are included in a quality control program.
- The receiving operation is the foundation for processing finished food products of a designated quality.
- Guidelines for incoming shipments are:
  - Be sure the storage space is clean and consistent with the first-in-first-out rotation principle.

FIFO or first-in-first-out rotation is the removal of inventory from storage in a systematic way where earlier stock items are used first.
- This can be accomplished by date coding the inventory according to the date of receipt.
- Before unloading, inspect the condition of the carrier.
- Measure temperature, observe and note foul odors, spills, and insects.
- For refrigerated and frozen products, temperature is critical.

Quality Assurance - A Model Program for the Food Industry

- Observe the condition of the containers for damage which could be a source of contamination.
- Collect random samples from the shipment and analyze or evaluate the samples in relation to specifications.
- After unloading, inspect the condition of the carriers and notice the condition of the floors and walls.
- Take note of any dirt, filth or residues and evidence of previous spills.
- Do not accept food, ingredient or packaging shipments combined with chemicals or poisonous substances.

If the shipment does not meet specifications, be prepared to reject all or part of the load.
- Minimize dock time.
- Move refrigerated or frozen items directly into storage.
- Date code all incoming shipments directly on the container or pallet load for stock rotation.
- Improper storage can adversely impact upon the quality of materials, ingredients and finished product.

Laboratory Analysis

- The establishment of specifications and standards is meaningless without laboratory analysis or an evaluation program.
- Laboratory analysis is the phase in which a quality control program is implemented after product is produced.
- A sampling plan, along with an analysis frequency (time schedule defining how often analyses are made), is absolutely necessary.
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- Compile the methods of analysis used in the laboratory in a special working notebook.
- Microbiological, chemical and physical analyses of food are available in the book, Official Methods of Analysis, published by the Association of Official Analytical Chemists.
- For some analyses, very simple methods are used in the laboratory.
- By example, for fruits or vegetables, color measurements and physical defects are sometimes determined by comparing the product to a chart.
- Other methods like a protein or fat analysis are more complicated and require specialized equipment.

- Microbiological methods performed on product whether it is poultry, red meat, dairy, vegetable or seafood also requires special instruments and equipment.
- Incubators and an autoclave are necessary in microbiological analyses.
- An incubator is used to control temperature conditions and allow bacteria to grow so groups of bacteria (colonies) can be counted.

- An autoclave is like a steam cooker.
- This piece of equipment is used to sterilize laboratory glassware and destroy bacteria, yeast or mold after an analysis.
- Destruction of the microorganisms is important so safe disposal is possible.
- Perform all laboratory analyses in a room away from the processing area.
- At times, a small food plant may not have a separate area.

- Therefore, there are three ways to obtain laboratory analysis results:
  - In-house lab.
  - Outside independent lab.
  - Combination of in-house and independent lab.
- Appoint a qualified individual to conduct analyses, report the results and manage the job of quality control.
- Have laboratory tests results recorded and compared to the specifications or standards.
- Deviations from standards should be communicated so that additional action can be taken if necessary.

- Many methods exist for the laboratory analysis of food. Examples of some methods are:
  - Standard plate count, a microbiological method used to count the numbers of bacteria contained in a product.
  - Yeast and mold count, a microbiological method used to count the number of yeast and mold in food.
  - A chemical method (pH) which determines if a food is acidic, neutral or basic.
  - Moisture, a chemical method to determine total water.
  - Protein, a chemical method to determine the protein.
  - Fat, a chemical method to determine total fat.

- Recall Plan
  - Product recall is having to bring back product from the distribution system.
  - Every food business is susceptible to potential product recall.
  - The public image of businesses can be destroyed during a recall if a well-organized plan is not implemented.
  - Why would a product be recalled?
  - Products are recovered from distribution as a result of voluntary action by a business firm or involuntary action due to Food and Drug Administrative (FDA) action.
  - The basic reasons for recall are best described by the FDA recall classifications.
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- CLASS I - As a result of a situation where there is reasonable probability that the use or exposure to a defective product will cause a serious public health hazard including death.

- CLASS II - As a result of a situation where the use of or exposure to a defective product may cause a temporary adverse health hazard or where serious adverse public health hazard (death) is remote.

- CLASS III - As a result of a situation where use of or exposure to a defective product will not cause a public health hazard.

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A Model Program for the Food Industry

- An example of Class I product recall would be contamination with a toxic substance (chemical or microbiological);

- A Class II product recall is where product is contaminated with food infection microorganisms,

- while a Class III example is where product does not meet a standard of identity.

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A Model Program for the Food Industry

- Because of recall potential, a food business firm must be prepared for the worst situation.

- A recall plan should be developed and communicated to appropriate individuals within the firm before an emergency arises.

- The plan should include:
  - An effective product coding system.
  - Coding should be simple, yet broad enough to minimize financial loss.
  - Date of manufacture, date code plus shift code, lot code or various combinations are possible.

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- A record keeping system to identify and associate specific product, product code, carrier and destination.

- A list of key personnel and their assigned responsibilities for a recall.

- Select key personnel from each of the following areas: production, quality control, marketing, shipping/receiving and legal counsel.

- A communication system within the firm and a system into the distribution marketing shipping/receiving channels and legal counsel.

- A communication system is critical to minimize rumor and the exaggeration or misstatement of the facts in and out of the business.

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Quality Assurance- 
A Model Program for the Food Industry

- Established procedures for evaluating and correcting situations.

- A good recall program is like an insurance policy. The program will not prevent an adverse situation from occurring. It will, however, help the business and personnel prepare for a possible recall.

- Food quality is an expectation of consumers. To meet this consumer need, every food business should develop and use an effective quality control program.

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Quality Assurance- 
A Model Program for the Food Industry

- Failure to meet consumer demand can cause a decline in product sales and profitability.

- A major product failure can totally destroy a business.

- Start or update quality control practices now, and continue to build the program for the future.

- In case there is doubt, ask two questions:
  - Are we doing things right?
  - Are we doing the right things?
Why it is needed?

- Quality monitoring is imperative in present times.

- This cardinal principle is universally accepted because it enables the producer and or seller to realize appropriate price of his produce or merchandise as the case be.

- The buyer or consumer gets the satisfaction for having paid the correct competitive price for the similar quality.

- The manufacturers and their manufacturing personnel also need to know the precise quality of the raw materials they are starting with, the quality of the intermediates formed so that through corrective steps the final product of the desired quality is obtained.

- Any produce released for sale must conform to statutory standards.

- In the absence of detailed methodology the reproducibility of the results suffers.

- The reproducibility of results is equally imperative while certifying the quality of a product.

- There is an absolute need of food analysts at operative and supervisory-level, food manufacturers and their processing technologists, advocates and judges handling court cases about quality disputes, students of analytical chemistry and food technology.

- Their need is not only a precise and concise methodology but also detailed information about the scope of the tests.

- Legal standards of the factors under test, differences of results due to factors human as well as operational and interpretation of result.

Food Analysis - Sampling and sample prep

Almost impossible to evaluate all the food or ingredient from a lot

select a portion and assume it is representative

Definitions

Sample - portion
Population - total quantity

Sample plan

Who, what, where, how - use of data determines the procedure - purpose, nature of product, method and population
**Food Analysis - Sampling and sample prep**

- **Attribute** - does it possess a certain characteristic? - two possible alternatives - present or absent
- **Variable** - estimate quantity of substance or characteristic

**Sampling risk**
- Consumer - accept sample that should have been rejected
- Vendor - reject a sample that should have been accepted

**Type of population**
- Homogeneous (all same) vs heterogeneous (variation)
  - Most samples are heterogeneous

**Heterogeneous sampling**
- Continuous - mechanically by a sampling device

**Manual** - attempt to take an unbiased sample (two types)
  1. Non-probability sampling - judgement, convenience, quota
  2. Probability sampling - random, systematic, cluster, composite

**Sample size**
- Want reliable data with minimum number of samples, calculate the number on a statistical basis

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**Sampling problems**
- Poor storage (heat, light, air), mislabeled

**What do you do now**
- Prepare for analysis
  1. Reduce in size, grinding
  2. Enzyme inactivate, protect from lipid oxidation, microbial growth

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**Sample**

- The Analytical Commission of Terminology of IUPAC (International Union of Pure and Applied Chemists) has proposed the definition of sample as "A portion of material taken from the consignment and selected in such a way that it possesses the essential characteristics of the bulk."
Sample

- An ideal sample should be identical in all its intrinsic properties with the bulk of the material from which it is taken.
- The sample should be large enough for all intended determinations.
- Homogenous samples of 250 g are generally sufficient.
- The size of the sample varies from product or material to material and type of analysis e.g. samples of spices are often limited to 100 g and of fruits or vegetables increased to 1000 g.
- The sample should be packed and stored in such a way that no significant change occurs from the moment of sampling until the analysis is completed.

Sampling Techniques

- The value of the result of a chemical analysis on a well prepared laboratory sample will depend on
  - how representative the sample is of the lot, batch, package or consignment of the particular food from which it was taken and
  - on kind of chemical information required.

- Foodstuffs are relatively heterogeneous materials, so sampling and any subsequent separation are the greatest source of error in food analysis.
- The problem may be minimized by selecting either randomly or according to a plan, several samples from the lot.
- In sampling foods and food products, sufficient material must be taken to compensate for the variability involved.

- The number of individual samples to be selected may be calculated from the following expression:
  \[ n = \frac{C \times N}{C} \]
  Where,
  - \( n \) = number of individuals to be selected
  - \( C \) = is a factor which represents the degree of accuracy desired in the sample, and
  - \( N \) = lot size.
  Where the extent of variability is not known, it is advisable to select at least ten times the amount to be taken as a sample for analysis.
  The sample selected should be representative, and reflect all the homogeneous parts of the heterogeneous population.

Preparation of Samples

- Generally, the errors in sampling are due to
  1. Lack of randomness in selection.
  2. Change in composition of product during sampling
  3. Non-homogeneity of food.

- In order to obtain precise analytical results, the laboratory sample must be made as homogeneous as possible so that, within the limits of analytical method used, the replicate analyses agree as closely as possible.
Preparation of Samples

- The purpose of sample preparation is to mix thoroughly a large sample in the laboratory.
- This apparently homogenous sample must be then reduced in size and amount for subsequent analysis.

Preparation of Samples

The problems encountered by the analysts in the preparation of samples for analysis include
1. Preparing representative small samples from large samples,
2. Loss of plant material,
3. Removal of extraneous material from plants without removal of plant constituents,
4. Enzymatic changes before and during analysis,
5. Compositional changes during grinding,
6. Metal contamination during grinding,
7. Changes in unstable components, and

Preparation of Samples

The sample to be prepared should be first homogenised and the method of homogenization will depend on the type of food being analyzed.
- A number of very efficient electrical mechanical devices are available to reduce the size of food particles and to mix food products thoroughly.
- Mincers, graters, blenders and homogenizers (for dry, moist and wet foods) and various types of powder mills or grinders are essential equipment in a food laboratory.
- Both the nature of food material and the analysis to be performed must be considered in the selection of instrument for grinding.

Preparation of Samples

Preparation of dry food samples
- Dry foods needs to be ground to at least coarse powder by means of a mechanical grinder and then mix thoroughly with a spoon or spatula.
- Bulk samples of dry or powdery foods can be reduced in size by the process known as quartering.
- For this spread the material on the large sheet of glazed paper, glass or clean surface of laminated bench or table. Draw a cross over the heaped material.

Quartering

- Remove the diagonally opposite segments.
- Remix the remaining segments and draw a cross over the heap.
- Again remove two opposite segment and mix the remaining.
- Repeat the processed until about 250 g remains.
- If needed, again grind the granular, material.
Quartering

- Second Quartering

...and so on
Preparation of Samples

For grinding of dry materials, mechanical methods range from the simple pestle and mortar to elaborate and effective devices for grinding.

- For fine grinding of dry materials, power-driven hammer mills are widely used.
- Hammer mills are used to grind such materials as cereals, oil meals and most foods, which are reasonably dry and do not contain excessively high amounts of oil or fat.

Grinding of oil seeds or oil rich samples present special problems.

- Dried fruits should be passed through chopper three times and mixed thoroughly.
- If needed, initially, grinding can be done by coarse cutting blade.
- Sonic and supersonic vibrations are also used for dispersion of foods.

During sampling, it is important to keep the chemical, physical and enzymatic degradation of lipids to a minimum.

Preparation of moist solid foods

Moist solid foods such as meat products are best homogenised by chopping rather than mincing.

- Cheese and chocolates are best grated followed by hand mixing of the, rated material.
- For disintegrations of moist materials various fine-slicing devices are available.

Some moist materials are disintegrated best by bowl cutters (leafy vegetables, fleshy tubers and roots) or meat mincers (fruits, roots and meat products).

- Chilled ball mills can be used to grind frozen materials without preliminary grinding.
- Grinding of frozen foods reduces undesirable chemical changes.
- The commercially available tissue grinders are also used for small sample of soft material.

Preparation of Samples

For preparation of sample of fresh fruits and vegetables, first of all it is essential to remove adhering soil or sand by washing or wiping with damp cloth.

- Excessive washing should be avoided to prevent leaching of soluble solids.
- Then, separate the fresh tissues into core, outer and inner tissue depending on the objectives of analysis.
- For large size fruits and vegetable cut these in four/eight equal portions containing inner to outer portion of fruits or vegetables.

Remove the pits from the flesh of stone fruits and then comminute the prepared material in the blender.

- For canned fruits and vegetables if analysis is to be made on the composite sample, mix and comminute the entire contents.
- But, if analyses are to be made on solid and liquid portions separately, drain the contents on a sieve and comminute the solid matter or collect the liquid as required for analysis.
Preparation of Samples

Preparation of semi-solid/liquid foods
- Fluid foods are best emulsified by top or bottom driven blenders.
- Fruit juice beverages containing insoluble matter, should be blended using high-speed blender to get uniform sample.

Preparation of Samples

Preparation of semi-solid/liquid foods
- Pureed products such as tomato puree, ketchup, fruit pulps and strained fruits and vegetables should be thoroughly shaken before sampling.
- Gentle warming and mixing easily prepare oils and fats.
- Butter and margarine may be re-emulsified by shaking by hand in a glass jar after warming to 35°C to melt the fat.

Preparation of Samples

Enzyme inactivation
- Enzyme naturally present may cause undesirable changes during preparation of samples for analysis.
- Generally, if total contents of a specified compound are determined i.e. minerals, carbohydrates, nitrogen, enzyme inactivation is not essential.
- But, if sugars, free and bound forms of lipids, groups of protein are to be determined, the tissues must be killed in such a way that potentially troublesome enzymes are immediately and completely inactivated.

Preparation of Samples

Enzymes may be inactivated with steam or boiling alcohol.
- Fungal amylases are generally heat labile and can be inactivated at relatively low temperatures; some bacterial amylases are highly heat resistant.
- Extraction of chlorogenic acid from seed or dry tissues requires heating to 90-100°C for 1 hr to inactivate polyphenolases.

Preparation of Samples

Some enzymes can be inactivated by inorganic compounds that cause irreversibly enzyme poisoning, by a shift in pH, or by salting out.
- The most common method of inactivating enzyme include treatment with 80% methanol or ethanol, ice-cold 5-10% perchloric or tri-chloroacetic acid or a mixture of methanol-chloroform-2M formic acid (12:5:3 by volume).
Sampling

- The validity of the conclusions drawn from the analysis of a food depends, among other things, on the methods used in obtaining and preserving the sample.
- Sampling and any subsequent separations may be the greatest sources of error in food analyses.

Sampling

- An ideal sample should be identical in all of its intrinsic properties with the bulk of the material from which it is taken.
- In practice, a sample is satisfactory if the properties under investigation correspond to those of the bulk material within the limits set by the nature of the test.

Sampling

- According to Kratochvil and Taylor (1981), the major steps in sampling are
  1. Identification of the population from which the sample is to be obtained,
  2. Selection and obtaining of gross samples of the population, and
  3. Reduction of each gross sample to a laboratory-size sample suitable for analysis.
- It has been shown that if the analytical uncertainty is less than one-third of the sampling uncertainty, additional reduction of the analytical uncertainty is of little significance.

Sampling

- Statistical sampling approaches were reviewed by Springer and McClure (1988). Four types of sampling methods were considered:
  - Simple random sampling: for populations, in which all elements have an equal and independent chance of being included in a sample,
Stratified random sampling

- **Stratified random sampling**: by separating the population elements into overlapping groups (strata) and selecting a simple random sample from each strata.

Systematic sampling

- **Systematic sampling**: drawing a \( \frac{1}{K} \) sample from a list of units, and

Select Nine Samples
Judgment sampling

- **Judgment sampling**: drawing samples based on the judgment an experience of the investigator.

Example of nine samples

Example of six samples

**Sampling**

- Factors affecting the ability of a plan to obtain a sample that accurately represents the concentrations of natural toxins (i.e., mycotoxins and seafood toxins) are:
  - Nature of the analyte,
  - Distribution of the analyte throughout the lot,
  - Physical characteristics of the product,
  - Accessibility of the product to random representative sampling,
  - Sampling procedure, and
  - Size of sample.
Sampling

- Sampling plans are composed of three components:
  - Sampling,
  - Sample preparation, and
  - Analysis.
- Normally, sampling contributes the largest relative error whereas analysis comprises the least.
- Automatic, continuous stream samplers provide the most representative samples for commodities such as nuts, cottonseed, and cereal grains.

Glossary of Sampling Terms

- Sample
  - A portion of a population or lot; may consist of an individual or groups of individuals.

Lot

Sample

Sub sample

A portion taken from a sample; a laboratory sample may be a sub sample of a gross sample; similarly, a test portion may be a sub sample of a laboratory sample.
Sub sample

Gross sample
Also called bulk sample, lot sample; one or more increments of material taken from a larger quantity (lot) of material for assay or record purposes.

Lot

Increment

Gross Sample

Composite sample
A sample composed of two or more increments.
Laboratory sample
A sample, intended for testing or analysis, prepared from a gross sample or otherwise obtained; the laboratory sample must retain the composition of the gross sample; often reduction in particle size is necessary in the course of reducing the quantity.

Test portion
- Test portion
  - Also called specimen, test specimen, test unit, aliquot; that quantity of a material of proper size for measurement of the property of interest; test portions may be taken from the gross sample directly, but often preliminary operations, such as mixing or further reduction in particle size, are necessary.

Segment
- Segment
  - A specifically demarked portion of a lot, either actual or hypothetical.

Lot

Glossary of Sampling Terms
- Strata
  - Segments of a lot that may vary with respect to the property understudy.
Strata

- Segment with conditions like
  - By weight
  - By volume
  - By colour, etc.

Population

- A generic term denoting any finite or infinite things, objects, or events in the broadest concept; an aggregate determined by some property that distinguishes things that do and do not belong.

Lot

- A quantity of bulk material of similar composition whose properties are under study.

Increment

- An individual portion of material collected by a single operation of a sampling device, from parts of a lot separated in time or space;
- increments may be either tested individually or combined (composited) and tested as a unit.
Individual

- **Individual**
  - Conceivable constituent part of the population.
  - Like one box of candies, bottle of ketchup, etc.

Bulk sampling

- Sampling of a material that does not consist of discrete, identifiable, constant units, but rather of arbitrary, irregular units.

Homogeneity

- The degree to which a property or substance is randomly distributed throughout a material;
- homogeneity depends on the size of the units under consideration;
- thus a mixture of two minerals may be inhomogeneous at the molecular or atomic level, but homogeneous at the particulate level.

Reduction

- The process of preparing one or more sub samples from a sample.

Sampling

- According to Kramer and Twigg (1970), factors that determine selection of a sampling procedure include
  - Purpose of inspection-acceptance or rejection, evaluation of average quality, and determination of uniformity;
  - Nature of lot-size, division into sublots, and loading or stacking;
  - Nature of test material-its homogeneity, unit size, previous history, and cost;
  - Nature of test procedures-significance, destructive or non-destructive assay procedures, and time and cost of analyses.

Sampling Errors

- Particle shape-round particles flow into the sampler compartments more readily than angular particles of similar size;
- Surface adhesiveness-an uncoated hygroscopic material flows into the sampler Compartment more readily than non hygroscopic materials of similar shape and of either larger or smaller size;
- Differential downward movement of particles (on the basis of size) when disturbed during sampling.
Quality Factors in Foods

Quality has been defined as degree of excellence and includes such things as taste, appearance, and nutritional content.

Quality

- More expensive foods can be a good value if their quality is very high.
- When we select foods and when we eat, we use all of our physical senses, including sight, touch, smell, taste, and even hearing.

Appearance factors

- Appearance factors include such things as size, shape, wholeness, and different forms of damage, gloss, transparency, color, and consistency.
- For example, apple juice is sold both as cloudy and clear juice.

Textural factors

- Textural factors include hand feel and mouthfeel of firmness, softness, juiciness, chewiness, grittiness. The texture of a food is often a major determinant of how little or well we like a food.
- For example, many people do not like cooked liver because of its texture. Texture of foods can be measured with sophisticated mechanical testing machines.

Flavor factors

- Flavor factors include both sensations perceived by the tongue which include sweet, salty, sour, and bitter, and aromas perceived by the nose.
APPEARANCE FACTORS

- size, shape, and wholeness, pattern (e.g., the way olives are laid out in a jar or sardines in a can) can be an important appearance factor
- Wholeness refers to degree of whole and broken pieces; the price of canned pineapple goes down from the whole rings, to chunks, to bits

Some ice cream manufacturers have added ground vanilla bean as a mark of highest quality, others have concluded that as often as not a less-sophisticated consumer misinterprets these specks and rejects the product.

Size and Shape

- Fruits and vegetables can be graded for size by the openings they will pass through
- Fruits and vegetables can be graded for size by the openings they will pass through

Some of the most difficult engineering problems encountered in such facilities were in designing equipment that would dispense odd-shaped food pieces into moving dishes.

Color and Gloss

- Food color not only helps to determine quality, it can tell us many things
- an index of ripeness or spoilage
- Potatoes darken in color as they are fried and we judge the endpoint of frying by color

The bleaching of dried tomato powder on storage can be indicative of too high an oxygen level in the headspace of the package, whereas the darkening of dried tomato can reflect too high a final moisture level in the powder.
Color and Gloss

- The color of a food foam or batter varies with its density and can indicate a change in mixing efficiency.
- The surface color of chocolate is a clue to its storage history.

Color and Gloss

- If the food is a transparent liquid such as wine, beer, or grape juice, or if a colored extract can be obtained from the food, then various types of calorimeters or spectrophotometers can be used for color measurement.

Color and Gloss

- With these instruments, a tube of the liquid is placed in a slot and light of selected wavelength is passed through the tube. This light will be differentially absorbed depending on the color of the liquid and the intensity of this color.

Color and Gloss

- Two liquids of exactly the same color and intensity will transmit equal fractions of the light directed through them. If one of the liquids is a juice and the other is the same juice somewhat diluted with water, the latter sample will transmit a greater fraction of the incoming light and this will cause a proportionately greater response on the instrument.

Color and Gloss

- Such an instrument can also measure the clarity or cloudiness of a liquid depending on the amount of light the liquid lets pass.

Food Quality

Tests Used for Objective Evaluation
Chemical methods

- Chemicals are estimated in food spoilage like
  - peroxides in fats.
  - Adulterants in food e.g.,
    - presence of starch in milk,
    - metanil yellow in turmeric powder and
    - loss of nutrients during cooking can be estimated.

Physico-chemical methods

- Measurement of hydrogen ion concentration can be found by the use of pH meter
  - It utilizes a glass indicating electrode and a reference electrode to complete the electrical circuit.
- Sugar concentration can be found by refractometer
  - It is used to determine the concentration of a sugar solution.
  - Light is refracted as it passes through sugar solution, with the specific values being calibrated in degrees, Brix, an indication of the percent of sucrose in the solution.

Physico-chemical methods

- Brix or Balling hydrometer gives directly the percentage of sugar by weight in the syrup.
- It is always necessary to make a temperature correction since the hydrometers are usually calibrated at 20°C.
- Each instrument used by canners usually covers a range of only 10° Brix, e.g. 10-20, 20-30, 30-40, 40-50, 50-60 Brix respectively and are graduated in 1 / 10th divisions.
- Brix is defined as percent sucrose measured by a Brix hydrometer.
- Since continued use of hydrometers in hot syrups affects their accuracy, they should be checked frequently by more accurate instruments.
- Polariscope is used for quantitative analysis of sugar.

Microscopic examination

1. Type of organisms present in fermented products like idli batter.
2. Examination of starch cells under the microscope for identification.
3. Spoilage of the food can be found out by observing the organisms under the microscope.
4. Size of crystals in sugar is related to smoothness of the product.
5. Number and size of the air cells in batters and foams.

Physical methods

- Weight
  - Weight of a food indicates the quality like in case of apple or egg.
- Volume
  - Liquid volumes can be measured by using measuring cups.
  - Solid food volume can be found by displacement method.
  - In this method the volume can be calculated by subtracting the volume of seeds held by a container with a baked product from that of volume of seeds without the baked product.
  - Usually mustard seeds are used.

Physical methods

- Specific volume
  - The determination of specific volume of any product should be done with care and average of replicates is to be taken since experimental errors are likely to be large.
  - Measurement of bulk volume in a porous and spongy product like idli is difficult.
  - The volume may be measured by displacement with solvents like kerosene.
Physical methods

- The idli is given a momentary dip in molten wax to seal off the pores.
- Increase in volume is taken as the measure of its bulk volume.
- Specific volume = \( \frac{\text{Bulk volume}}{\text{Wt. of the substance}} \)

Physical methods

- **Index to volume**
  - It can be found by measuring the area of a slice of food with a planimeter.
  - It is important to use a slice that is representative of the product such as a centre slice.
  - Index to volume is a measurement made by first tracing detailed outline of a cross section of the food.
  - This tracing can be done with a sharply pointed pencil or a pen or by making a clear ink blot of the cross section.

Physical methods

- The ink blot is made simply by pressing the cross section of the sample lightly onto an inked stamp pad and then making the imprint of the inked sample on paper.
- A planimeter can also be used to trace the entire outline of the sample, being careful to follow all indentations and protrusions so that the final measure recorded on the planimeter represents the circumference of the slice.

Physical methods

- **Specific gravity**
  - It is a measure of the relative density of a substance in relation to that of water.
  - The measurement is obtained by weighing a given volume of the sample and then dividing that weight by the same volume of water.
  - This technique is used for comparing the lightness of products physically unsuited to the volume measurements e.g., egg white foams.
  - Potatoes with low specific gravity (waxy type potatoes) have cooking characteristics different from those of potatoes with a comparatively higher specific gravity.

Physical methods

- **Moisture**
- **Press fluids:** Initial weight of the sample is noted.
- After the appropriate pressure has been applied for a controlled length of time, the sample is again weighed.
- The difference between the two weights represents the amount of juice contained in the original sample e.g. juiciness of meats, poultry and fish.
- **Drying:** The weight of the original sample is determined and then the food is dried until the weight remains constant.

Physical methods

- **Wettability**
  - Baked products can be tested for moisture level by conducting a test for wettability.
  - For this test, the sample is weighed before being placed for 5 seconds in a dish of water.
  - Immediately at the end of the lapsed time, the sample is removed from the water and weighed again to determine the weight gain.
  - High moisture retention is synonymous with good wettability, a sign that a cake probably will be considered to be appropriately moist when judged subjectively.
Physical methods

- **Cell structure**
  - Cell structure of baked products is an important characteristic to measure the uniformity, size and thickness of cell walls.
  - Photocopies of cross-sectional slices give this valuable information.
  - This technique gives a third-dimensional view into the cells on the cut surface of the sample and gives the actual size clearly.

Physical methods

- **Measurement of colour**
  - Colour is the first quality attribute a consumer perceives in food.
  - Change of colour is generally accompanied by flavour changes.

Physical methods

- **Size of the grain**:
  - This can be found by using photography or ink prints with a stamp pad or sand retention, e.g., idli.
  - Retention of sand is more if the grains are coarse.
  - Cut the idli into 2 pieces and take one piece and press it on the stamp pad and take an impression on the paper.
  - Ink prints may be less clear but satisfactory for some purposes.
  - **Photography**:
    - This may be in colour or black and white. They may not represent the sample size, so a marked ruler should be kept adjacent.

Physical methods

- **Disc colorimeter**.
  - Here the discs have radial slits so that a number of them may be slipped together with varying portions of each showing.
  - The discs are spun on a spindle at about 2700 rpm so that the colours merge into a single hue without flickering.
  - The test sample is placed adjacent to the spinning disc under controlled illumination and both are viewed simultaneously.
Physical methods

- **Coloured chips:** A simple method is to match the colour of the food with the colour chips or colour glass, chart or colour tiles.
- This method is not very satisfactory as it is difficult to match the food with one small block of colour or the chart.
- The data are difficult to tabulate and analyse also.

- **Spectrophotometer:** Visual matching of colours is subject to shortcomings of human observers.
- To overcome this spectrophotometer can be used.
- In this, tube with the liquid is placed in a slot and light of selected wavelength is passes through the tube.
- This light will be differentially absorbed depending upon the colour of the liquid and the intensity of the colour.

Physical methods

- Two liquids of exactly the same colour and intensity will transmit equal fractions of the light directed through them.
- If one of the liquid is a juice and the other is the juice diluted with water, the latter sample will transmit a greater fraction of the incoming light and this will cause a proportionately greater deflection of the sensing needle on the instrument.
- Such an instrument can also measure the clarity, cloudiness of a liquid depending on the amount of light the liquid allows to pass.

SENSORY EVALUATION

- When the quality of a food product is assessed by means of human sensory organs, the evaluation is said to be **sensory or subjective or organoleptic**
- The effective characteristic is not the property of the food, but the subject's reaction to the sensory qualities of foods.
- This reaction is highly conditioned by a variety of psychological and social factors - plays a vital role in the acceptance and preference of foods.

SENSORY CHARACTERISTICS OF FOOD

- **Appearance** - Surface characteristics
- Scrambled egg with a very dry surface is not acceptable.
- Fudge with a glossy surface is rated high.
- Lumps in a pudding or gravy which are not desirable can be judged by the eye.
- Sight plays a role in the assessment of the lightness of foods like the bread, cakes and idli.
- Keep this perception of the size, shape of the foods and of such characteristics as transparency, opaqueness, turbidity, dullness and gloss is mediated by the organs of sight.
SENSORY CHARACTERISTICS OF FOOD

- Quality of fish can be ascertained by the brightness of the eyes of fish.
- Quality of sweet limes can be found out by appearance.
- If the skin is thin it is juicier.
- Infestation with insects can be found out in brinjal by the appearance of black spots on it.
- Completeness of cooking can be judged by appearance in products like meat and rice.

- Colour
  - Ripeness of fruits like banana, tomato, mango, guava, papaya and plum can be assessed by the colour.
  - The strength of coffee and tea is judged in part by the colour of the beverages.
  - The colour of roast beef is used as an index to doneness.
  - Toast, dosa, and chapathi which are too brown are likely to be rejected in anticipation of scorched bitter taste.

- Flavour
  - The flavour of food has three components-odour, taste and a composite of sensations known as mouth feel.

- Odour
  - A substance which produces odour must be volatile and the molecules of the substance must come in contact with receptors in the epithelium of the olfactory organ.
  - It is estimated that the olfactory sense of man has the capacity to distinguish 16 million odours-wow!!!!

- Taste
  - Taste sensation which the taste buds register are categorised as sweet, salt, sour or bitter.
  - Taste buds in the different areas of the tongue are not equally sensitive to all taste stimuli and at least some taste cells respond to more than one stimulus.
  - Taste buds near the tip of the tongue are more sensitive to sweet and salt.
  - Those on the sides to sour and those near the back to bitter.
The sensation known as **sour** is associated with hydrogen ions supplied by acids like vinegar and by those found in fruits and vegetables.

**Salt** taste is due to ions of salt.

Sodium chloride is said to be the only one with a pure salt sensation.

Substances which elicit the **sweet** sensation are primarily organic compounds like alcohols, certain amino acids, and aldehydes.

Glycerol tastes mildly sweet.

Sugars are the main source of sweetness in food.

Fructose gives the most intense sweet sensation followed by sucrose, glucose, maltose, galactose and lactose.

Sweetness appears to be associated with the hydroxyl radicals on the sugar molecules.

The concentration required for identification is known as the "threshold" for that particular substance.

Individuals differ in their sensitivity to the four taste sensations and the threshold for each of the primary tastes is usually not at the same level in any one individual.

The pleasant sensations in eating come more from odour than from taste.

Taste interaction: Foods contain mixture of substances which elicit all four taste sensations.

Salt in sub threshold concentration reduces the tartness of acid.

Some threshold concentrations of salt also increase the apparent sweetness of sucrose.

The addition of salt to lime juice, sherbet, *lassi*, and to fruits like apple or guava improve the taste.

Conversely acids in sub threshold concentration intensify the saltiness of sodium chloride so it is easy to over salt tart foods.

Sugar in sub threshold concentration reduces the saltiness of sodium chloride so a pinch of sugar may improve vegetable soup that has been over salted.

Sugar also reduces the sourness of acids and the bitterness of coffee.

**Mouth feel**: Texture and consistency and hotness or burning sensation of pepper can be felt in the mouth.
SENSORY CHARACTERISTICS OF FOOD

- **Temperature**: Hot and cold sensations contribute to the composite flavour of a food like coffee, soup or ice cream.
- Taste sensations are less intense as the temperature of food is lowered below 20°C and raised above 30°C.
- Thus really hot coffee is not as bitter as that which has cooled in the cup, iced coffee is not as bitter as that which is warm but not really hot.
- Melted ice cream tastes unpleasantly sweet although in the frozen state it is acceptable.

- **Texture**: Texture in ice cream depends upon the size of the crystals.
- How they feel on the tongue is characterized as coarse or fine.
- Coarse textured crystalline products are said to be grainy.
- The brittleness of food is another aspect of texture.
- Tissues in a raw vegetable and fruit are brittle or crunchy.
- The cells offer moderate resistance to fraction by the pressure of the teeth e.g. crispness of apple and raw carrots.

- **Tenderness**: Tenderness in fruits and vegetables depends on how easily the cells separate.
- In meats ease of separation of the lean (without fat) tissue determines the tenderness.
- Tenderness in pastry is assessed by the ease with which the crisp crust breaks.

- **Astringency**: It is dry *puckery sensation* believed to be due to precipitation of the proteins in the saliva and in the mucous membrane lining of the mouth which deprives them of their lubricating character.
- Astringent substances may also constrict the ducts leading from the salivary glands to the mouth.
- Unripe fruits like cashew fruit, wood apple, blue berry and gooseberry are astringent.

- **Consistency**: Ice creams may be too hard or too soft which can be found out by mouth feel.
- Gravies, sauces and syrups range in consistency from thick to thin.
- Temperature may affect the consistency of food e.g. ghee, butter, cheese and ice creams.
- The consistency of soft custard besides being thick or thin may be smooth or curdled.
- Cream soups may be smooth or lumpy.
- Gels may be rubbery or fragile (easily breakable).
- Particles of cooked cereal can be pasty or separate in grains.

- **Psychological factors**: In addition to colour, odour, taste and mouth feel certain psychological factors contribute to the acceptability of foods.
- Food is accepted when there is pleasant association.
CONDUCTING SENSORY TESTS

- **Trained panel members**
  - From early times this judging has been the preserve of experts who used to evaluate tea, coffee and wine.
  - With the development of sensory evaluation techniques on scientific lines, the experts are being replaced by panels whose sensitivity and consistency have been established by training and repeated tests.
  - The panel members analyse food products through properly planned experiments and their judgments are quantified by appropriate statistical analysis.

Selection of panel of judges

- Actually one extremely discriminating pains taking and unbiased individual would suffice for tasting.
- Further one individual may not be able to discriminate different aspects of food quality.
- Hence a panel of judges may be used.
- Members of the panel should be carefully selected and trained to find out difference in specific quality characteristics between different stimuli and also direction and intensity of difference.

The requirements for an ideal panel member

- (i) He should be able to discriminate easily between samples and should be able to distinguish appreciable differences in taste and smell.
- (ii) He should have good health.
  - If he is suffering from cold his sensitivity may be affected.
  - A sick patient cannot judge the food correctly.
- (iii) He should be experienced in the particular field.
- (iv) He should have high personal integrity.
  - He should not be prejudiced.
  - He should be able to evaluate objectively.

The requirements for an ideal panel member

- (v) Willingness to spend time for the sensory evaluation work is required.
- (vi) He should have interest in sensory analysis of samples and intellectual curiosity.
- (vii) He should have ability to concentrate and derive proper conclusion.
- (viii) He should be available and willing to submit to periodic test to get consistent results.
- Candidates possessing these qualities must be indexed with details of age, sex, specific likes and dislikes availability.

Types of Panels

- **Trained panel**
- **Discriminative, communicative or send trained panels**
- **Consumer panels**

Trained panel

- Laboratory panels must then be carefully trained for specific products or purposes.
- These tests aim at finding differences in specific quality characteristics between different stimuli and also direction and/or intensity of the difference.
- Periodically the panel is given refresher training and tests.
- The number of members in the trained panel should be small varying from 5 to 10.
Discriminative, communicative or send trained panels

- These panels are constituted of technical people and their families, who are normally familiar with the qualities of different types of food.
- They are capable, with few preliminary test runs, of following instructions for tests given, discriminating differences and communicating their reactions.
- Such panels of 25-30 are used to find the acceptability or preference of final experimental products prior to large scale consumer trials.

Consumer panels

- Such panels are made up of untrained people chosen at random to represent a cross-section of the population for which the product is intended.
- The greater the number the greater the dependability of the result.
- A group of not less than 100 is considered the minimum.

Testing laboratory

- Testing laboratory consists of five separate units.
  - (i) Reception room where the panel members meet the person in charge of the laboratory and get acquainted with the type of the samples to be tested.
  - (ii) The sample preparation room which is clean and well equipped for the preparation and serving of samples.
  - (iii) The test booths are where the actual sensory evaluation of the samples are carried out by the panel members.
The Test Booths

Testing laboratory

- The entire testing laboratory should be air-conditioned, free from noise and extraneous odours.
- Whenever samples with difference in colours are tested, colour lights should be used to mask the colour of the samples.
- Stainless steel glass and dishes and cups and plain serving china are the most convenient as utensils.

Preparation of samples

- Samples for presentation must be from homogeneous lot.
- Careful sampling of the food is necessary for sensory evaluation.
- Samples to be tested should be prepared by identical methods.
- All samples should be at the same temperature, optimum level and kept constant during the test.
- Stainless steel forks and spoons can be used for tasting the samples.
- Samples are presented with 3 to 5 digit code markings to obscure the identity of the samples.
- The order of presentation should also be randomised within each test session.

Techniques of smelling and tasting

- For odour tests of food products a special technique is used to perceive the aroma more clearly.
- Smelling is done with short, rapid sequence of sniffs.
- Tasting of coffee or tea or fruit juice is done by slurping.
- One teaspoon of the liquid is rolled on the tongue so that the liquid reaches all parts of the tongue where the taste buds are located.

Testing time

- Testing should be done at a time when the panel members are fresh.
- The test time is generally between 10 to 12 in the morning.
- Too many samples should not be given as they may produce fatigue and lead to errors in the results (Not more than 4-5 samples at a time).

Design of experiment

- Experimental error can be minimised through the use of techniques of randomizing.
- A statistical design is used in order to measure variables separately and together and to establish the significance of results.
- The experiment should be designed on the basis of the accuracy needed and the amount of sample available.
Reasons for testing food quality

- **To know the consumer preference.**
  - This helps the producer to discover which qualities of the product need to be developed and emphasized.
  - He should obtain the cross-section of all potential consumers.
  - Consumer preference panels may consist of several hundred persons and the products are tested under ordinary conditions of use.
  - The results are considered to represent the taste of the significant portion of the population and are used to predict market outlook for a product.

Reasons for testing food quality

- **Effect of variation in processing on quality**
  - Tests are done to investigate the influence of factors in production.
  - They should have the ability to distinguish among degrees of difference in flavour.
  - The members of this type of panel are not required to be expert tasters of the product under investigation.

Reasons for testing food quality

- Their highly developed ability to identify different tastes in similar products is the key quality required.
  - Its purpose is to determine whether a given variation in processing has altered the quality of flavour of the products.
  - It is also used to test the effects of storage and packaging on two items originally alike but subjected to different storage environment.

Reasons for testing food quality

- **To detect the presence of off-quality**
  - Here the panel members are usually trained to recognise and to evaluate the standard flavours of food so that they can use their powers of discrimination consistently, e.g. rancidity in fats and butter.

EVALUATION CARD

- The questionnaire or score card should be prepared carefully for each test.
- The card should be clearly typed or printed.
- It should be simple and use unambiguous terms and directions in the desired sequence of action as a guide to the evaluation.

EVALUATION CARD

- The design of score cards for sensory evaluation is challenging and difficult because the key characteristics of the product need to be evaluated on paper in a way that permits the judges to transmit their assessments of the samples accurately to the researcher.
- A score card with too much detail and clutter may discourage careful judgment; too brief a form may fail to obtain some important information.
EVALUATION CARD

- A score card may be as simple as indicating which sample is different as is done when duo-trio or triangle testing is the mode being used.
- A sheet for indicating rank order for a single characteristic also is extremely simple.
- It is in the descriptive tests that the score card becomes a critical part of the planning for an experiment.

EVALUATION CARD

- A table utilizing the hedonic ratings ranging from unacceptable to very acceptable is relatively easy to construct.
- No single score card fits all experiments.
- Instead, the score card needs to be developed for the specific experiment.
- All score cards should contain the date and name of the judge.

TYPES OF TESTS

- Different sensory tests are employed for food evaluation. The tests are grouped into four types.
  A. Difference tests.
  B. Rating tests.
  C. Sensitivity tests.
  D. Descriptive tests.
- The selection of a particular test method will depend on the defined objective of the test, accuracy desired and personnel available for conducting the evaluation.

A. DIFFERENCE TESTS

- A1. Paired Comparison Test
- A2. Duo-Trio Test
- A3. Triangle Test

A1. Paired Comparison Test

- (i) The panel members receive several pairs of samples. These may be different or the same samples in each pair. Samples are always given in code numbers.
- (ii) Different samples are given in each pair which differ in the intensity of one characteristic e.g. sweetness, bitterness or rancidity. In each pair the sample with more or less intense taste will have to be picked out.
- Specimen evaluation card

A1. Paired Comparison Test

- Specimen evaluation card

* Specimen evaluation card

# Name: ____________________________ Date: ____________________________

Product: ____________________________

Are you given one or several pairs of samples? Evaluate the two samples in the pair.

Is there any difference between the two samples in the pair?

Code no. of pairs: ____________________________

Yes / No

Signature: ____________________________
A2. Duo-Trio Test

- This test employs three samples, two identical and one different.
- The panel is first given one of the pair of identical samples as known reference sample and then the other two successively in random order, and asked to match one of these with the first.
- A positive answer is required even if it is a guess.
- The chance probability of placing the samples in a certain order is one-half.
- Trained or untrained panelists can be used.

A3 Triangle Test

- This test employs three samples, two identical and one different, presented simultaneously to the panel.
- The judge is asked to determine which of the three the odd sample is.
- A positive answer is required even if it is a guess. Since all three samples are unknown, the chance probability of placing the sample in a certain order is one-third.
- Two samples A and B can be presented in two combinations AAB and BBA and for replication in six different arrangements AAB, ABA, BAA, BAB, ABB and BBA.
- Note: With experience it is possible to study another dimension, the degree of difference in this test.

B. RATING TESTS

- These tests give more quantitative data than difference tests and can be used for the analysis of more than two samples at the same time.
- B1. Ranking Test
- B2. Single Sample (Monadic) Test
- B3. Two Sample Difference Test
- B4. Multiple Sample Difference Test
- B5. Hedonic Rating Test
- B6. Numerical Scoring Test
- B7. Composite Scoring Test

B1. Ranking Test

- This test is used to determine how several samples differ on the basis of a single characteristic.
- A control need not be identified.
- Panelists are presented all samples simultaneously (including a standard or control if used) with code numbers and are asked to rank all samples according to the intensity of the specified characteristic.
- In consumer analysis, the panelists are asked to rank the coded samples according to their preference.
**B1. Ranking Test**

Specimen evaluation card

Name: ___________________________ Date: ___________________________

Product: ___________________________

Please rank the samples in numerical order according to your preference or intensity of an aroma/taste characteristic of the product.

<table>
<thead>
<tr>
<th>Intensity/Preference</th>
<th>Sample code</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td></td>
</tr>
</tbody>
</table>

Comments: (type of off-flavour, etc.)

Signature

---

**B2. Single Sample (Monadic) Test**

- This test is useful for testing foods that have an aftertaste or flavour carry over which precludes testing a second sample at the same session.
- The panelist is asked to indicate the presence or absence and/or intensity of a particular quality characteristic.
- With trained panelists, the completed analyses of two or more samples evaluated at different times can be compared.
- Also, in market and consumer analysis, the results of different samples evaluated at different times by a different set of untrained panelists can be compared.

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**B3. Two Sample Difference Test**

- This test is a variation of the paired comparison test and measures the amount of difference.
- Each taster is served four pairs of samples.
- Each pair consists of an identified reference and coded test sample.
- In two pairs, the test sample is a duplicate of the reference sample.
- In the other two pairs, the test sample is the test variable.
- The panelist is asked to judge each pair independently as to the degree of difference between the test sample and standard on a scale of '0' representing no difference to '9' representing extreme difference.
- Additional questions on direction of difference can also be asked.
- The panelist is not to guess and he is panelized for guessing through the coded duplicate standards in two pairs.

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**B4. Multiple Sample Difference Test**

- In this test, more than one test variable can be evaluated per session but with reduced reliability.
- Each panelist is served 3-6 samples depending upon the number of test variables.
- One sample is a known standard.
- The panelist compares each coded sample with the known standard.
- One coded sample is a duplicate of the standard.
- Whatever score the panelist assigns to the blind standard is subtracted from the score he assigns to the test variables.
- The panelist is not to guess.
- Direction and degree of difference is also to be judged.
B4. Multiple Sample Difference Test

You are given a standard or reference sample and a test sample to compare. The test sample may be at different stages of processing, maturity, cooking, etc. The panelist is asked to indicate if there is a difference and the direction of the difference according to the following scale:

<table>
<thead>
<tr>
<th>Rating</th>
<th>Difference from standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None</td>
</tr>
<tr>
<td>1</td>
<td>Large</td>
</tr>
<tr>
<td>2</td>
<td>Important</td>
</tr>
<tr>
<td>3</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

The panelist is also asked to indicate the direction of difference and write comments indicating the decision of quality.

B5. Hedonic Rating Test

- Hedonic rating relates to pleasurable or non-pleasurable experiences.
- The hedonic rating test is used to measure the consumer acceptability of food products.
- From one to four samples are served to the panelist at one session. He is asked to rate the acceptability of the product on a scale, usually of 9 points, ranging from 'like extremely' to dislike extremely.
- Scales with different ranges and other experience phrases could also be used.
- The results are analysed for preference with data from large untrained panels.
- Semi-trained panels in smaller number are used to screen a number of products for selecting a few for consumer preference studies.
- When pronounced aftereffects are met with, precluding testing of a second sample or when independent judgments are sought for, separate cards are used for each product.
- When relative preference is the object of study, cards with multiple columns for the number of test samples are used.

B6. Numerical Scoring Test

- One or more samples are presented to each panelist in random order or according to a statistical design.
- The panelist evaluates each sample on a specific scale for a particular characteristic indicating the rating of the samples.
- The panelists are trained to follow the sensory characteristics corresponding to the agreed quality descriptions and scores.
- Without this understanding the rating will not be of any use.
B7. Composite Scoring Test

- The rating scale is defined so that specific characteristics of a product are rated separately.
- The definition of the rating scale is weighed so that the most important characteristics will account for a large part of the total score.
- The resulting scores are compounded for any one panelist to arrive at a composite score.
- This method is helpful in grading products and comparison of quality attributes by indicating which characteristic is at fault in a poor product.
- It gives more information than the straight numerical method.
- The panelists are trained to evaluate the dimensions of the individual quality characteristic critically, and in the use of the weighed scale.

C. SENSITIVITY TESTS

- Sensitivity tests are done to assess the ability of individual to detect different tastes, odours and feel the presence of specific factors like astringency or hotness (pepper).
- These tests are used to select and train panel members for evaluating the quality of products containing spices, salt and sugar, e.g. tomato ketchup or sauce.

C1. Sensitivity-Threshold Test

- Sensitivity tests to measure the ability of an individual to smell, taste or feel specific characteristics in food or beverages or pure substances are used frequently in selecting for evaluations in product research and development.
- Also, they are used to establish intensity of sensory response of a food or food components.

C1. Sensitivity-Threshold Test

- Threshold Test. Threshold is defined as a statistically determined point on the stimulus scale at which a transition in a series of sensations or judgments occurs.
- There are mainly three types of threshold as described below:
- (a) Stimulus detection threshold is that magnitude of stimulus at which a transition occurs from no sensation to sensation.
C1. Sensitivity-Threshold Test

- (b) Recognition identification threshold is the minimum concentration at which a stimulus is correctly identified.
- (c) Terminal saturation threshold is the magnitude of a stimulus above which there is no increase in the perceived intensity of the stimulus.

The recognition threshold tests with basic tastes or odours are most frequently employed for panel selection and with materials such as spices for assessing the intensity of odour or flavour as the main threshold value by a trained panel.

The threshold value is given as a mere number which is the denominator of the dilution where the odour or flavour is recognized.

These tests are also used where a minimum detectable difference of an additive or of an off-flavour are to be established.

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<th>C2. Dilution Test</th>
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Dilution tests are designated to establish the smallest amount of an unknown material, developed as a substitute for a standard product that can be detected when it is mixed with the standard product, e.g., margarine in butter, dried whole milk in fresh milk, synthetic orange flavour ingredients with natural flavour and so on.

The quality of the test material is represented by the dilution number which is the percent of the test material in the mixture of the standard product such that there exists a just identifiable difference in odour and taste between them.

The bigger the dilution number the better is the quality of the test material.

D. Descriptive Flavour Profile Method

This is both qualitative and quantitative description method for flavour analysis in products containing different tastes and odour. For tomato ketchup the flavour profile analysis is given.
Limitations of sensory evaluation

1. The result may be highly variable.
2. People with colds or other health problems temporarily lose their maximum effectiveness.
3. Emotional burdens may influence an individual's ability.

OBJECTIVE EVALUATION

Methods of evaluating food quality that depend on some measure other than the human senses are often called objective methods of evaluation.

Advantages
- Confidence can be gained as they are reproducible.
- The results would be accurate. Human sensitivity is not involved. Minute differences can be noticed by doing objective tests.
- They are less subjected to errors when compared to sensory methods.
- These methods provide permanent record. So that comparison can be made over a period of time.
- They are not affected by factors other than the one being measured.
- Emotional burdens and individual ability can be overcome.

Disadvantages
- It is time consuming.
- It is expensive.
- Technical knowledge is required.
- Instruments may not be available sometimes.
- Some aspects of food cannot be evaluated by objective methods e.g., flavour.
- Usually both sensory and objective methods are done.
- Objective evaluation supplement or reinforce the data obtained subjectively through sensory evaluation.

Basic guidelines

1. Conduct all objective tests appropriate to the experiment for which equipment is available: For example, checking the pH of mixtures prior to and after heating.
2. This information often is valuable in explaining results.
3. Flow properties of batters or certain other mixtures prior to heat treatment can be measured and that information used in interpreting and explaining results.
Basic guidelines

2. Obtain necessary testing devices:
In the preliminary testing phase of an experiment, analyse all steps in the preparation of the product and study the final product to determine whether there are specific characteristics that might be tested objectively if additional testing equipment could be procured or developed for the experiment.

3. Be meticulous about maintenance of objective equipment. Before using any equipment, the good researcher will check to be certain the machine is operating correctly in all aspects.

4. Carefully define the samples to be used for objective testing. A template of the item being tested often is an essential tool in obtaining comparable samples for objective tests.
   - The dimensions of pastry or cookie samples being tested for tenderness on the Shortometer must be identical.
   - To obtain these samples, the thickness of the mixture prior to baking must be controlled precisely.

5. Establish operating conditions for objective testing: For example, the temperature of a starch paste being utilised for a linespread test must be specific and controlled so that the effect of temperature on viscosity of starch pastes is not an uncontrolled variable in the measurement.
   - Samples to be controlled in size, storage and temperature.
   - Each experiment needs to be designated to eliminate uncontrolled variables in objective testing.

Computers in Sensory Analysis of Food

Softwares in Food Analysis

- Compusense Five
- SI MS 2000 Demo
**What are standards?**

- Standards are documented agreements containing technical specifications or other precise criteria to be used consistently as:
  - rules,
  - guidelines, or
  - definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose.

- For example, the format of the credit cards, phone cards, and “smart” cards that have become commonplace is derived from an ISO International Standard.
- Adhering to the standard, which defines such features as an optimal thickness (0.76 mm), means that the cards can be used worldwide.
- International Standards thus contribute to making life simpler, and to increasing the reliability and effectiveness of the goods and services we use.

**Why is international standardization needed?**

- The existence of non-harmonized standards for similar technologies in different countries or regions can contribute to so-called "technical barriers to trade".
- Export-minded industries have long sensed the need to agree on world standards to help rationalize the international trading process.
- This was the origin of the establishment of ISO.

- **Worldwide progress in trade liberalization**
  - Today's free-market economies increasingly encourage diverse sources of supply and provide opportunities for expanding markets.
  - On the technology side, fair competition needs to be based on identifiable, clearly defined common references that are recognized from one country to the next, and from one region to the other.
  - An industry-wide standard, internationally recognized, developed by consensus among trading partners, serves as the language of trade.

- **Interpenetration of sectors**
  - No industry in today's world can truly claim to be completely independent of components, products, rules of application, etc., that have been developed in other sectors.
  - Bolts are used in aviation and for agricultural machinery; welding plays a role in mechanical and nuclear engineering and electronic data processing has penetrated all industries.
  - Environmentally friendly products and processes, and recyclable or biodegradable packaging are pervasive concerns.
Why is international standardization needed?

- **Worldwide communications systems**
  - The computer industry offers a good example of technology that needs quickly and progressively to be standardized at a global level.
  - Full compatibility among open systems fosters healthy competition among producers, and offers real options to users since it is a powerful catalyst for innovation, improved productivity and cost-cutting.

- **Global standards for emerging technologies**
  - Standardization programmes in completely new fields are now being developed.
  - Such fields include advanced materials, the environment, life sciences, urbanization and construction.
  - In the very early stages of new technology development, applications can be imagined but functional prototypes do not exist.
  - Here, the need for standardization is in defining terminology and accumulating databases of quantitative information.

- **Developing countries**
  - Development agencies are increasingly recognizing that a standardization infrastructure is a basic condition for the success of economic policies aimed at achieving sustainable development.
  - Creating such an infrastructure in developing countries is essential for improving productivity, market competitiveness, and export capability.

- **The aim is to facilitate trade, exchange and technology transfer through:**
  - enhanced product quality and reliability at a reasonable price;
  - improved health, safety and environmental protection, and reduction of waste;
  - greater compatibility and interoperability of goods and services;
  - simplification for improved usability;
  - reduction in the number of models, and thus reduction in costs;
  - increased distribution efficiency, and ease of maintenance.

What is ISO?

- The International Organization for Standardization (ISO) is a worldwide federation of national standards bodies from some 140 countries, one from each country.
- ISO is a non-governmental organization established in 1947. The mission of ISO is to promote the development of standardization and related activities in the world with a view to facilitating the international exchange of goods and services, and to developing cooperation in the spheres of intellectual, scientific, technological and economic activity.
- ISO’s work results in international agreements which are published as International Standards.

ISO’s name

- Many people will have noticed a seeming lack of correspondence between the official title when used in full, International Organization for Standardization, and the short form, ISO. Shouldn’t the acronym be “IOS”? Yes, if it were an acronym – which it is not.
- In fact, “ISO” is a word, derived from the Greek isos, meaning “equal”, which is the root of the prefix “iso-” that occurs in a host of terms, such as “isometric” (of equal measure or dimensions) and “isonomy” (equality of laws, or of people before the law).
- From “equal” to “standard”, the line of thinking that led to the choice of “ISO” as the name of the organization is easy to follow. In addition, the name ISO is used around the world to denote the organization, thus avoiding the plethora of acronyms resulting from the translation of “International Organization for Standardization” into the different national languages of members, e.g. IOS in English, OIN in French (from Organisation internationale de normalisation). Whatever the country, the short form of the Organization’s name is always ISO.
How it all started?

- International standardization began in the electrotechnical field: the International Electrotechnical Commission (IEC) was created in 1906. Pioneering work in other fields was carried out by the International Federation of the National Standardizing Associations (ISA), which was set up in 1926. The emphasis within ISA was laid heavily on mechanical engineering.

ISA's activities ceased in 1942, owing to the Second World War.

Following a meeting in London in 1946, delegates from 25 countries decided to create a new international organization "the object of which would be to facilitate the international coordination and unification of industrial standards".

The new organization, ISO, began to function officially on 23 February 1947.

The first ISO standard was published in 1951 with the title, "Standard reference temperature for industrial length measurement".

Who makes up ISO?

- ISO is made up of its members who are divided into three categories:
  - A member body of ISO is the national body "most representative of standardization in its country".
  - Only one body in each country may be admitted to membership of ISO.

- A member body takes the responsibility for:
  - Informing potentially interested parties in their country of relevant international standardization opportunities and initiatives;
  - Ensuring that a concerted view of the country's interests is presented during international negotiations leading to standards agreements;
  - Providing their country's share of financial support for the central operations of ISO, through payment of membership dues.

- Member bodies are entitled to participate and exercise full voting rights on any technical committee and policy committee of ISO.

- A correspondent member is usually an organization in a country which does not yet have a fully developed national standards activity. Correspondent members do not take an active part in the technical and policy development work, but are entitled to be kept fully informed about the work of interest to them.

- ISO has also established a third category, subscriber membership, for countries with very small economies. Subscriber members pay reduced membership fees that nevertheless allow them to maintain contact with international standardization.

Food laws and Standards

- The Government of India is fully aware to the possibilities of food being adulterated.
- Effective means of food quality can be achieved by legislative measures, certification schemes and public participation and involvement in the programme.
Food laws and Standards

- It has therefore, empowered several agencies and promulgated a number of acts and orders to contract the menace.
- Agencies and institutions have also been created to lay down standards for the quality of foods.
- The manner in which the food is processed and packaged is also covered by a number of regulations. Following measures have been taken by the government to control the quality of food.

Prevention of food adulteration act (PFA)

- One of the early acts to be promulgated in this connection was the Prevention of Food Adulteration Act of 1954, which has been in force since June 1, 1955.
- The objective of this act was to ensure that food articles sold to the customers are pure and wholesome.
- It also intended to prevent fraud or deception and encourages fair trade practices.
- The act was amended in 1964 and again in 1976 in the light of experience gained, to plug loopholes of escape in the Act and to insure stringent punishment for those indulging in this nefarious practice.

Prevention of food adulteration act (PFA)

- The Act prohibits the
  - manufacture,
  - sale and
  - distribution of not only adulterated foods but also foods contaminated with toxicants and misbranded foods.

Prevention of food adulteration act (PFA)

- PFA specifies microbial standards for
  - pasteurized milk,
  - milk powder,
  - skimmed milk powder,
  - infant milk food,
  - tomato sauce,
  - jam,
  - malted milk food and aflatoxins for ground nut.

Prevention of food adulteration act (PFA)

- A Central Food Laboratory located at Calcutta and the Central Food Technological Research Institute, Mysore has also been recognized for testing of adulterated foods.
- "A central committee for food standards" has been constituted under the Act and has been charged with the function of advising the Central Government on matters relating to the Food standards.

Prevention of food adulteration act (PFA)

- Provisions have been made in the Act for the appointment of Food Inspectors by the state Governments and their powers have been defined.
- The State Government will set up food testing laboratory and will appoint Public Analysts with adequate staff to report on suspected foods.
Prevention of food adulteration act (PFA)

According to the Prevention of Food Adulteration Act, an article of food shall be deemed to be adulterated:
- If the article sold by a vendor is not of the nature, substance or quality demanded by the purchaser and is to his prejudice, or is not of the nature, substance of quality which it purports or is represented to be.
- If the article contains any other substance which affects, or if the article is so processed as to affect injuriously the nature, substance or quality there of.
- If any inferior or cheaper substance has been substituted wholly or in part for the article, so as to affect injuriously the nature, as substance or quality there of.
- If any constituent of the article has been wholly or in part abstracted so as to affect injuriously the nature, substance or quality there of.
- If the article had been prepared, packed or kept under unsanitary conditions whereby it has become contaminated or injurious to health.
- If the article consists wholly or in part of any filthy, putrid, disgusting, rotten, decomposed or diseased animal or vegetable substance or is insect-infested or otherwise unfit for human consumption.
- If the article is obtained from a diseased animal.
- If the article contains any poisonous and ingredient which renders its contents injurious to health.
- If the container of the article is composed, whether wholly or in part of any poisonous or deleterious substance which renders its contents injurious to health.
- If any colouring matter other than that prescribed in respect there of and in amounts not within the prescribed limits of variability is present in the article.
- If the article contains any prohibited preservative or permitted preservative in excess of the prescribed limits.
- If the quality or purity of the article falls below the prescribed standard or its constituents are present in quantities which are in excess of the prescribed limits of variability.
Administrative hierarchy

- The Food Health Authority is appointed at state level who is the Director of Public Health and Preventive Medicine.
- He is responsible for the good quality and standards of foods available to the consumers.

Under FHA is the Local Health Authority (LHA).

- There is a Local Health Authority appointed in each city in every state.
- The food Inspector is appointed by the Central or State Government by notification in official gazette.
- The Food Inspector undergoes a three months training in food inspection and sampling.

Powers of food inspectors

- To take sample of any food article from
  - Any person selling such article.
  - Any person who is in the course of delivering or preparing to deliver such article to a purchaser or consignee.
  - A consignee after delivering of any such article to him.

- To send such sample for analysis to the Public Analyst (PA) of local area.
  - When the Food Inspector wants to lift suspected food the shop keeper must first be told.
  - There should be a witness present when the Food Inspector lifts the sample.

- 150g of the sample is necessary to be sent for analysis. 600g of sample is collected usually and sent to
  1. Ripon Buildings, Corporation of Madras
  2. Kings’ Institute, Guindy, Madras
  3. Central Food Laboratory, Calcutta
  4. Central Food Technological Research Institute, Mysore.

- There is certain procedure to collect the sample and seat it in a bottle.
- The sealed bottle has a label on it in which the code number of the Inspector, address of the shop and date and time of collection are written.
- When individuals doubt adulteration in food stuffs they have to inform the Food Health Authority. Samples can be sent for analysis only after getting order from Food Health Authority.
Powers of food inspectors

- If persons are found guilty of selling such adulterated food, the persons involved can be convicted.
- Severity of sentence would depend on the gravity of the offence.
- For example, a vendor found adulterating the food with ingredients injurious to health would liable for a much heavier sentence than a vendor involved in only mixing an inferior ingredient not injurious to health.

Fruit Products Order (FPO), 1995

- Fruit Products Order -1955, promulgated under Section 3 of the Essential Commodities Act - 1955, aims at regulating sanitary and hygienic conditions in manufacture of fruit, vegetable products.
- It is mandatory for all manufacturers of fruit, vegetable products to obtain a license under this Order.

Fruit Products Order (FPO), 1995

- To ensure good quality products, manufactured under hygienic conditions, the Fruit Product Order lays down the minimum requirements for:
  1. Sanitary and hygienic conditions of premises, surrounding and personnel.
  2. Water to be used for processing.
  3. Machinery and equipment.
  4. Product standards.

Fruit Products Order (FPO), 1995

- Besides this, maximum limits of preservatives, additives and contaminants have also been specified for various products.
- This order is implemented by Ministry of Food Processing Industries through the Directorate of Fruit & Vegetable Preservation at New Delhi.

Fruit Products Order (FPO), 1995

- The Directorate has four regional offices located at
  1. Delhi,
  2. Mumbai,
  3. Calcutta and
  4. Chennai, as well as
- sub-offices at
  1. Lucknow and
  2. Guwahati.
Fruit Products Order (FPO), 1995

- The Central Fruit Advisory Committee comprising of the officials of concerned
  - Government Departments,
  - Technical experts,
  - representatives of Central food Technology Research Institute,
  - Bureau of Indian standards,
  - Fruits and Vegetable Products and processing Industry,
- Responsible for recommending amendments in the Fruit Product Order.

In view of the demands of the industry, and the liberalised economic scenario, major amendments were made in FPO during 1997.

Standards

- I.S.I. Standards
- Various committees, including representatives from
  - the government,
  - consumers and
  - industry,
- formulate the Indian Standards Institution (ISI).

I.S.I. Standards

- Standards are laid for vegetable and fruit products, spices and condiments, animal products and processed foods.
- The products are checked for quality by the ISI in their own network of testing laboratories at Delhi, Bombay, Calcutta, Madras, Chandigarh and Patna or in a number of public and private laboratories recognized by them.

The AGMARK Standard

- The word AGMARK is a derived from Agricultural Marketing.
- The AGMARK standard was set up by the Directorate of Marketing and Inspection of the Government of India by introducing an Agricultural produce Act in 1937.
- The word 'AGMARK' seal ensures quality and purity.

The AGMARK Standard

AGMARK BESAN
SL. NO. B-162002
GRADE-STANDARD
PLACE OF PACKING....................
DATE OF PACKING....................
NET WEIGHT............................
THIS LABEL IS THE PROPERTY OF THE GOVERNMENT OF INDIA.
A lot of care is taken in laying down the AGMARK grade and in affixing the AGMARK quality label. The quality of a product is determined with reference to the size, variety, weight, colour, moisture, fat content and other factors are taken into account. The act defines quality of cereals, spices, oil seeds, oil, butter, ghee, legumes and eggs and provides for the categorization of commodities into various grades depending on the degree of purity in each case.

The grades incorporated are grades 1, 2, 3 and 4 or special, good, fair and ordinary. The standards also specify the types of packaging to be used for different products. The physical and chemical characteristics of products are kept in mind while formulating the AGMARK specifications.

The Directorate of Marketing and Inspection of Central Government has 21 laboratories and 50 sub offices spread all over the country. The Central AGMARK Laboratory at Nagpur, continuously carries out research and development work in this field.

The “Certificate of Authorization” is granted only to those in the trade having adequate experience and standing in the market. The staff of the Directorate of Marketing and Inspection or of the State Government is generally present at the time of selection of goods, their processing, grading and packing before applying the appropriate AGMARK labels.

Grading of commodities like ghee, butter, vegetable oils, atta, spices and honey is voluntary. On the other hand, grading of commodities like tobacco, walnuts, spices, basmati rice, essential oils, onions, potatoes are meant for export is compulsory under AGMARK. AGMARK ensures the quality of produce to the importers.

The process of grading and administering the programme entails some cost hence graded products are priced slightly more. Considering the quality that is assured that little extra cost is worth paying.
The AGMARK Standard

- Grading of agricultural commodities has three main purposes.
- Firstly, it protects the producer from exploitation.
- By knowing the quality and grade of his produce, he is in better bargaining position against the trader.

- Secondly, it serves as a means of describing the quality of commodities to be purchased or sold by the buyers and sellers all over the country and abroad.
- This establishes a common trade language and avoids the need for physical checking and handling at many points.
- Thirdly, it protects the consumer by ensuring the quality of products he purchases.

Export inspection council

- The council has been constituted to check the quality of a number of food materials meant for export.
- The council has powers to reject any food, which does not measure up to the standards prescribed for the food.
- Canned food such as mango juice, pineapple juice, frozen food such as shrimp, pomfrets are subject to scrutiny by this body before export.

Export (Quality Control and Inspection) Act, 1963

- The Export Inspection Council under the Ministry of Commerce is responsible for implementation of this Act under which a large number of exportable commodities have been notified for compulsory pre-shipment inspection.

Export (Quality Control and Inspection) Act, 1963

- The quality control and inspection of various export products is administered through a network of offices located in the important production centers and ports of shipment.
- In addition, other organizations may also be recognized as agencies for inspection and/or quality control.

- Recently, the Government of India have exempted agricultural produce food and fruit products, fish and fishery products from compulsory pre-shipment inspection, provided the exporter has a firm letter from the overseas buyer stating that the overseas buyer does not want pre-shipment inspection from any official Indian Inspection Agencies.
Hazard Analysis and Critical Control Point (HACCP)

- Hazard Analysis and Critical Control Point (HACCP) is an important quality assurance system. This system ensures that the products are safe and of good quality.
- The system is extremely desirable in view of the changing scenario in the International trade.

NSF-International strategic Registration Limited, USA, is the main authority for certifying HACCP-9000.

HACCP is an important requirement for ensuring the quality of products from health and safety aspects and is crucial for exports.

Introduction to HACCP

HACCP Stands for

- Hazard Analysis
- and Critical Control Point

HACCP is

- Preventive, not reactive
- A management tool used to protect the food supply against biological, chemical and physical hazards
Origins of HACCP

- Pioneered in the 1960’s
- First used when foods were developed for the space program
- Adopted by many food processors and the U.S. government

HACCP

- HACCP is not a zero-risk system.
- It is designed to minimize the risk of food safety hazards.

Recommendation:

“The HACCP approach be adopted by all regulatory agencies and that it be mandatory for food processors.”
1985 National Academy of Sciences

Seven Principles of HACCP

1. Conduct hazard analysis and identify preventive measures
2. Identify critical control points (CCPs) in the process
3. Establish critical limits
4. Monitor each CCP
5. Establish corrective actions
6. Establish verification procedures
7. Establish record-keeping and documentation procedures

HACCP is not a stand-alone system.

HACCP Inspections

HACCP inspections complement traditional inspection methods

HACCP:
- Emphasizes process control
- Concentrates on the points in the process that are critical to the safety of the product
- Stresses communication between the regulator and industry
HACCP Responsibility

"It is the responsibility of the food industry to develop and implement HACCP plans and for regulatory agencies to facilitate this process."

NACMCF, June 1993

Meaning of HACCP: Hazard Analysis Critical Control Points

The principles of the HACCP:
- Internationally accepted, systematic, preventive method to ensure the safety of food.
- Establishment and assessment of possible hazards and risks for a given product or group of products and handling of the selected critical control points, supplemented with documentation and permanent revision.

Hazard: Biological, chemical or physical material in, or condition of, food with the potential to cause adverse health effect.

Critical Control Point (CCP): A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Food safety:

is one attribute of food quality

QUALITY
Healthy, nutritive, palatable and suitable for consumption

SAFETY
Not dangerous for consumers’ health

Development of food safety

1. The increase of food safety is not conscious (natural, “bio” food, environment)
2. Methods and operations based on experiences and traditional methods to increase food safety (drying, smoking, salting, fermenting, boiling, etc.)
3. Technological, hygienic directions in written forms, cookery books (winter slaughtering, smoking, longer cooking time, kitchen, personal hygiene)
4. Today: technology, science, development of food law regulation

Some diseases have disappeared or were forced into background: enteric fever, typhoid dysentery, Clostridium, Staphylococcus

New problems: - caused by foods-irradiation, GMO hazard
Increasing Salmonellosis, Campylobacteriosis

New fears: E. coli O157:H7, BSE, dioxin

More danger have been detected only or the risk of food consuming has been really increased?

Sources of hazards

1.) Biological, microbiological hazards
- pathogen microorganisms: bacteria, fungi
- mycotoxins
- viruses
- parasites, protozoa
- prions

2.) Chemical (toxicological) hazards
- natural toxic materials (plants, animals)
- chemical hazards originated from environmental contamination (toxic elements and compounds, heavy metals, PCBs, dioxins)
- agricultural chemical residues (antibiotics, growth hormones, pesticides, fertilisers)

- Chemicals formed during the processing of foods (smoking, grilling: N-nitrosamines, polycyclic aromatic hydrocarbons, chemicals released from materials in direct contact with food)
- Residues and transformed forms of (intentionally added) food additives (brine, nitrite, nitrate)
- accidental or careless contamination
- adulteration or intentional poisoning

3.) Physical hazards
- environment (metal, wood, glass, paper)
- equipment (spare part, corroded, rusted surface)
- person (hair, jewel, button, surgical plaster)
- animal (insects, rodents, birds)

4.) Other hazards
- Every real hazard which can not be placed in the former categories

- contamination by radioactive fallout
- new technologies like application of genetically modified organisms in food processing
**Causes of appearance and increase of hazards:**

- Appearance of half-ready or ready-made convenient foods
- Development of word trade and tourism
- Intensive agricultural, horticultural technologies, fertilisers, pesticides, use of GMO grains
- Use of feeds of animal origin and of antibiotics in breeding

**Food quality assurance**

- GMP (Good Manufacturing Practice)
- GHP (Good Hygiene Practice)
- HACCP (Hazard Analysis and Critical Control Points)
- ISO-9000 (Quality Management Systems)
- TQM (Total Quality Management)

**GMP (Good Manufacturing Practice):**

- Professional, technical, technological and practical recommendations and requirements, which have to be followed by the food manufacturers to produce foods of constantly good quality and safety.
- These requirements can be of general validity or referring to a special area of the food industry. Their application is voluntary.

**GCP (Good Catering Practice):**

- In contrast to other countries GMP has not been applied in Hungary, but the feeding regulation contains its elements.

**GHP (Good Hygiene Practice):**

- A detailed description of the ways how can a food manufacturer obtain the best hygiene level in the whole plant, or in different production units.
- They are of general usage or are limited to a special area.

**The history of HACCP system**

- **1960:** The HACCP system was developed by Pillsbury Company, NASA and US Army to produce safe foods for the US space programme. (Their aim was to guarantee a specially required safety of the foods for astronauts, which could not be achieved with the traditional control of end product)
- **1971:** The HACCP concept was presented to public at a food safety conference
- **1973:** HACCP principles were adapted by the major food companies in US (first in the canning industry)
- **1980:** The use of HACCP concept is rapidly growing in Europe
1993: the FAO/WHO Codex Alimentarius Committee of Food Hygiene emitted the Directive 1993/43 EC regarding the application of HACCP system. This is the source document of this international method and the base of the Directive 18/1993 of the Hungarian Codex Alimentarius.

1995 December: the introduction of HACCP system is obligatory in EU countries.

Acting Clause of Law 1995/XC contains the first obligatory directions for the application of HACCP system in Hungary.

The Joint Regulation 17/1999 (II.10 FVM-EüM) makes obligatory the introduction of HACCP system for food manufactures with the date of 01. 01. 2002.

The Joint Regulation 80/1999 (XII.28 GM-EüM-FVM) refers to the introduction of HACCP system in catering.

Principles of HACCP

1. Conduct a hazard analysis
2. Determine the Critical Control points (CCPs) in the process
3. Establish critical limits for preventive measures associated with each identified CCP
4. Establish a system to monitor control of the CCP
5. Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control
6. Establish procedures for verification to confirm that the HACCP system is working effectively
7. Establish documentation concerning all procedures and records appropriate to these principles and their application

Application of the HACCP principles

1. Definition of the application area of HACCP system

Define the specific area of the food chain to which the HACCP system refers
- company
- process

Example: The preparatory kitchen and the catering processes of a catering company from the purchasing of raw materials to the transport of the product was examined.
2. Assemble and train the HACCP team

- Organising an internal HACCP team, representing different professional areas (5-6 person), nominating a leader.
- Experts are requested to participate (if needed)
- A review lecture is proposed to be held about the importance, advantages and difficulties of the HACCP concept.

2. Assemble and train the HACCP team (Cont’d)

Example: The members of HACCP team are: the owner, chef cook, supplier, commercial leader, maintenance man, cleaner.
The owner appointed the cook to be the leader of the team.
The work is supported occasionally by invited external expert (hygienist, microbiologist, quality controller).

3. Description of raw material and final product

- Composition
  - Physical/chemical composition (aw, pH, etc.)
  - Treatments that kill or prohibit microbe growth (heat treatment, freezing, curing, smoking, etc.)
- Packaging
- Conditions during storage
- Transport

Example: the product parameters like composition, manufacturing, sensorial characteristics, storage and conditions of transport are given in recipes.

4. Identify intended use and consumer groups

The intended use of food should be based on:
- the expected uses of the product and habits of the consumers
- the particular or sensitive groups of the population

Example: The foods are consumed immediately after preparing or after after some kitchen operations (e.g. heating). The planned use was taken into account in the system. Diabetic meals are separately cooked.

5. Construction of a flow diagram by the HACCP team

Flow diagram: a systematic representation of all the steps in the operations, used for the production or manufacture of a particular food item
- It must include each steps of the production in their right order.
- In the development of flow diagram the followings should be considered:
  - the previous and following steps
  - the flow diagram should not be too complicated

Example: Preparation of salads:

- raw materials
- cleaning
- chopping
- dressing
- weighing
- storage
- serving
6. On-site verification of flow diagram

The HACCP team:
- Should inspect the operation and verify the accuracy and completeness of the flow diagram at every step and the whole period of food preparation.
- The diagram should be modified when appropriate.

7. Hazard analysis (see Principle 1.)

The HACCP team:
- Should list all the possible hazards of each step of the process.
- Should make a hazard analysis: which hazards reduction or elimination are necessary for the safe food production (based on practical experience, the frequency and potential of hazards should be given).

- The HACCP team:
- Must consider what control measures can be applied for each hazard (It is possible that for one single hazard more control measures are needed and with one certain regulation more hazards can be controlled).
- Consider that the control measures should not be very loose or extremely strict!

E.g.: roasting, cooking

- overcooking - procedure description
- insufficient heat treatment - procedure description
- inadequate heating medium - procedure description
- dirty heating equipment - hygiene instructions

8. Determination of Critical Control points (see Principle 2.)

Critical control point (CCP): a step, where control can be applied to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

The CCPs are determined with the application of a decision tree, which should be flexible, or another approaches may be used.

- If a hazard has been identified at a step where control is necessary for food and no control measure exists, the product or the process should be modified to include a control measure!
Critical limit: a criterion which separates acceptability from unacceptability.

- In some cases more than one critical limit will be elaborated at a particular step.
- Critical points often used include measurements of temperature, time, moisture level, pH, $a_w$, available chlorine and sensory parameters such as visual appearance and texture.

**Example:**

<table>
<thead>
<tr>
<th>Step</th>
<th>Hazard</th>
<th>Cause of hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>cooking</td>
<td>insufficient cooking</td>
<td>less cooking time</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Critical limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>temperature</td>
<td>72 °C</td>
</tr>
<tr>
<td>time</td>
<td>2 minutes</td>
</tr>
</tbody>
</table>

**10. Establish a monitoring system for each CCP (see Principle 4.)**

Monitoring: The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a CCP is under control.

- Critical control points are compared to critical limits.
- Monitoring should provide information in due time (rapid method measurements).

**Example:**

<table>
<thead>
<tr>
<th>Step</th>
<th>Hazard</th>
<th>Critical limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>crumbing</td>
<td>cracked or spoiled egg</td>
<td>use of cracked egg is prohibited</td>
</tr>
</tbody>
</table>

The corrections should be taken before a deviation occurs.

- Data derived from monitoring must be evaluated by a designated person with knowledge and authority to carry out corrective actions when indicated.
- All documents (method, frequency, responsible) and records associated with monitoring CCPs must be signed by a person doing the monitoring.
11. Establish corrective actions (see Principle 5.)

Corrective action: Any action to be taken when the results of monitoring at the CCP indicate a loss of control.

- Specific corrective actions must be developed for each CCP, and responsible person should be appointed.
- Deviation and product disposition procedures must be documented.

Example:

<table>
<thead>
<tr>
<th>Step</th>
<th>Hazard</th>
<th>Corrective actions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>shipping contamination</td>
<td>canceling the transportation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Responsible</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>deliverer</td>
<td>trading sheets</td>
</tr>
</tbody>
</table>

12. Establish verification procedures (see Principle 6.)

Verification: the application of methods, tests and other evaluations, in addition to monitoring to determine compliance with HACCP plan.

Example:

- Revision of the measures regarding deviations and unacceptable product dispositions.
- Applying of external examinations (random samples from trade, consumers’ claims, experiences).

13. Establish documentation and record keeping (see Principle 7.)

Efficient and accurate record keeping is essential in the application of an HACCP system.

- Examples of documentation (handbook, worksheets):
  - hazard analysis,
  - determination of CCPs,
  - determination of critical limits,
  - determination of monitoring activities,
  - determination of deviations and associated corrective actions.

- Examples of records (official reports, notes):
  - results of the revisions
  - register of the deviations and associated corrective actions
  - modifications to HACCP system
  - verifications
  - training (attendance list)
Other directives, notes, which are not directly connected to the HACCP system:
- production technology,
- storage specifications,
- maintenance notes,
- work or task decisions,
- consumers’ claims.

Training, education
- Developing working instructions and procedures which define the tasks of the operating personnel.
- Holding an overall introduction lecture for the employees about the role of HACCP.
- Workers should be informed about the changes and developments (quarterly).
- Periodical training for workers.

Good advises for introduction of HACCP system
- The personnel should be involved in system from each working level of the company!
- If you want to involve experts from your own company for assembling the HACCP team, invite only quality control and HACCP experts!
- If you do not have experts, do not do it yourselves!

It is proposed not to fix unnecessary information and not to do a complicated documentation!
- At certain periods of time the system needs actualisation and revision.

Benefits of the HACCP system
- The trust of the customers to the product and to the company is increasing (is an evidence, that the process is under control and the producer implements all the regulations)
- The hazards caused by food, the “foodborne” infections can be cost-effectively regulated (instead of final quality control, the control is preventive)
- It increases the trade possibilities in the EU and outside EU
- It reduces the risks originated from the technical development
- It gives opportunity for the training of the team and the workers
- It can be applied for the whole food chain
- It takes into account everything related to food safety
- It is an overall, flexible system, which is compatible with other quality management systems.

**What is ISO 9000?**
- ISO 9000 is a standard in which to conduct business
- It is a set of rules which should be followed in order to meet the needs and understand the wants of customers
- The standard is generic

**How is ISO 9000 Being Implemented Today?**
- ISO 9000 is being used in many organizations with mixed results
- If an organization implements ISO 9000 in order to simply remain competitive and without mutually beneficial goals in mind, it will most likely fail in the long term

**ISO Implementation**
- Implementing ISO 9000 in an organization can be very beneficial
- The goal of this implementation is to achieve customer satisfaction at its highest level

**How can ISO 9000 be used in a business?**
- ISO 9000 can benefit many industries, such as: Banking, Health Care, Manufacturing, etc.
- ISO 9000 is generic, so it can be applied virtually anywhere!
- Remember, ISO 9000 is just one part of an entire system needed to create value for customers
How can ISO 9000 be used in business? (cont.)

- To begin the process, a commitment must be made.
- Once a commitment is made, what should an organization do?

How can the organization benefit from implementation of ISO 9000?

ISO 9000: In Depth

- ISO is not an acronym.
- ISO is a name used for the International Organization for Standardization.
- The ISO was formed in 1947 in Geneva, Switzerland.

ISO 9000: In Depth (cont)

- ISO 9000 is a European Standard.
- The organization has two stated objectives:
  1. To promote development of standardization to facilitate international exchange of goods and services.
  2. To promote cooperation in intellectual, scientific, technological, and economic activity.

What are the parts of ISO 9000?

- ISO 9000 is composed of 5 different, but related parts:
  ISO 9000, 9001, 9002, 9003, and 9004.
- ISO 9000 and 9004 are guidelines, while ISO 9001, 9002, and 9003 are the categories in which a company may apply for certification.

Part 1: ISO 9000

- Written in order to determine which category your organization should apply for.

Part 2: ISO 9001

- This is the category for companies which are involved in manufacturing or the creation and delivery of a service.
Part 3: ISO 9002
- Companies who perform many functions, with the exception of design and development, may apply to this category

Part 4: ISO 9003
- ISO 9003: “Quality Systems – Model for Quality Assurance in Final Inspection and Test”
- This category is useful for outside of the manufacturing sector, such as in distributors
- ISO 9003 is being used less and may be dropped in the future

Part 5: ISO 9004
- Used in order to help interpret the categories included in ISO 9000 certification

The costs of implementing ISO 9000
- Implementing ISO 9000 can be beneficial, but costly. The cost can be affected by:
  Multiple Locations
  Design
  Non-existence of a Quality Program
  Significant Corporate Changes

ISO 9000 Structure Chart

The cost of registering for ISO 9000
- Registering for ISO 9000 creates additional costs which vary based upon:
  Design Responsibility
  Number of Locations
  Size of Facility in Terms of Employment
Other ISO Programs

- ISO 9000:2000
  ISO 9000 upgraded for 2000
- ISO 14000
  ISO 14000 is environmental certification for an organization
  Not as prominent, as environmental issues are more complex than ISO 9000 issues

Summary: ISO 9000

- ISO 9000 is a standard in which organizations conduct business
- ISO 9000 has 5 parts
- ISO 9000 is a generic standard
- There are currently over 70,000 organizations registered for ISO 9000 certification

Requirements for ISO 9001 Certification

- Determine quality policy, objectives, and commitment.
- Document the policy.
- Communicate the policy to everyone in the company.
- Ensure that the policy is maintained and enforced.

Certification Process: Management

- Management decides to go for the certification
- Assign a management representative to head up the certification process.

Certification Process: Teams

- Management Team
- Documentation Team
- Calibration Team
- Audit Team
- Review Team

Certification Process: Prepping the Company

- Teams create, document, and implement a quality control (QC) process.
- QC Process is a process to maintain final product quality at a constant level.
  Process can take 3-24 months
Certification Process: Registration
- Made through a carefully selected registrar.
- Registrar and auditors inspect QC process documentation.
- Registrar makes a pre-assessment to find any obvious problems with the process or process documentation.

Certification Process: Registration
- Registrar and auditors make a final assessment of the company.
  - Make sure QA process is being implemented by interviewing employees and managers.
  - Can take a few days to a few months, depending on the size of the company and the number of processes being certified.

Certification Process: Certification
- Three options
  - Approved
  - Conditionally Approved
  - Not Approved

The Payoff
- More international and government customers.
- Leaner and more efficient operation.
- Increased customer confidence in company.
And...

Bottom Line
- Certification is expensive and takes a lot of time and effort but the costs are earned back in an average of 10 years.
- The benefits outweigh the costs in the long run.
- Plus, the business won’t end up like these guys...

Total Quality Management (TQM)
- Introduction
- Total Quality Management (TQM), a buzzword phrase of the 1980’s, has been killed and resurrected on a number of occasions.
- The concept and principles, though simple seem to be creeping back into existence by "bits and pieces" through the evolution of the ISO 9001 Management Quality System standard.
Companies who have implemented TQM include Ford Motor Company, Phillips Semiconductor, SGL Carbon, Motorola and Toyota Motor Company.

The latest changes coming up for the ISO 9001:2000 standard’s “Process Model” seem to complete the embodiment.

TQM is the concept that quality can be managed and that it is a process.

The following information is provided to give an understanding of the key elements of this process.

Total Quality Management (TQM)

Total = Quality involves everyone and all activities in the company.

Quality = Conformance to Requirements (Meeting Customer Requirements).

Management = Quality can and must be managed.

TQM = A process for managing quality; it must be a continuous way of life; a philosophy of perpetual improvement in everything we do.

TQM Compared to ISO 9001

ISO 9000 is a Quality System Management Standard.

TQM is a philosophy of perpetual improvement.

The ISO Quality Standard sets in place a system to deploy policy and verifiable objectives.

An ISO implementation is a basis for a Total Quality Management implementation.

Where there is an ISO system, about 75 percent of the steps are in place for TQM.

The requirements for TQM can be considered ISO plus.

Another aspect relating to the ISO Standard is that the proposed changes for the next revision (1999) will contain customer satisfaction and measurement requirements.

In short, implementing TQM is being proactive concerning quality rather than reactive.

TQM as a Foundation

TQM is the foundation for activities which include;

- Meeting Customer Requirements
- Reducing Development Cycle Times
- Just In Time/Demand Flow Manufacturing
- Improvement Teams
- Reducing Product and Service Costs
- Improving Administrative Systems Training

Ten Steps to Total Quality Management (TQM)

1. Pursue New Strategic Thinking
2. Know your Customers
3. Set True Customer Requirements
4. Concentrate on Prevention, Not Correction
5. Reduce Chronic Waste
Total Quality Management (TQM)

6. Pursue a Continuous Improvement Strategy
7. Use Structured Methodology for Process Improvement
8. Reduce Variation
9. Use a Balanced Approach
10. Apply to All Functions

Total Quality Management (TQM)

• Principles of TQM
  1. Quality can and must be managed.
  2. Everyone has a customer and is a supplier.
  3. Processes, not people are the problem.
  4. Every employee is responsible for quality.
  5. Problems must be prevented, not just fixed.
  6. Quality must be measured.
  7. Quality improvements must be continuous.
  8. The quality standard is defect free.
  9. Goals are based on requirements, not negotiated.
  10. Life cycle costs, not front end costs.
  11. Management must be involved and lead.
  12. Plan and organize for quality improvement.

Total Quality Management (TQM)

13. Processes must be Managed and Improved
14. Processes must be managed and improved! This involves:
15. Defining the process
16. Measuring process performance (metrics)
17. Reviewing process performance
18. Identifying process shortcomings
19. Analyzing process problems
20. Making a process change
21. Measuring the effects of the process change
22. Communicating both ways between supervisor and user

Total Quality Control (TQC)

• TQC
• Total Quality Control (TQC) is not a new concept. The original book entitled 'Total Quality Control' was written by Armand Feigenbaum, in 1951, where he noted the universal importance of quality to customers:

Total Quality Control (TQC)

• "Quality is the basic customer decision factor for an explosively growing number of products and services today—whether the buyer is a housewife, an industrial corporation, a government agency, a department store chain or a military defense program."

Total Quality Control (TQC)

• As a result, he proposed that quality be move out of the factory floor, where it mostly lived then, and into the rest of the company. In his words (and his italics):
Total Quality Control (TQC)

- "Quality is in its essence a way of managing the organization."

It was thus an extension of Quality Control (QC) to the totality of the whole company.

The term TQC was not, however, a term that sat well with American management, so some kind soul converted it into TQM, or Total Quality Management. BS.4778:Part 2(1991) described it as:

'Total Quality Control (TQC)

- 'A management philosophy embracing all activities through which the needs and expectations of the customer and the community and the objectives of the organization are satisfied in the most efficient and cost effective way by maximizing the potential of all employees in a continuing drive for improvement.'

TQM was well accepted and became a very popular worldwide fad. However, as with most fads, the basics were sound but the implementation in the majority of companies was fundamentally flawed.

So, for many firms, the round of blaming took its usual course, with most fingers pointed on the fad and any handy consultants or internal people who had nailed their colors too high on the mast.

This, of course, is excellent news for companies who are serious about quality.

Whilst the benefits of a temporary quality focus fade into the cost-cutting dust, the real players will reap the real rewards.

System for optimizing production based on ideas developed by Japanese industries from the 1950s on.

The system, which blends Western and Eastern ideas, began with the concept of quality circles, in which groups of 10–20 workers were given responsibility for the quality of the products they produced.
Total Quality Control (TQC)

- It gradually evolved into various techniques involving both workers and managers to maximize productivity and quality, including close monitoring of staff and excellent customer service.
- The concept of *kaizen*, the notion that improvement must involve all members of a company, is central to TQC.