FOOD SCIENCE AND NUTRITION

Third Edition

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Preface to the Third Edition

The second edition of Food Science and Nutrition received an overwhelming response and served the purpose of arousing interest in this subject in students, staff, and the community at large. The simple language and style of presentation has helped people with minimum science background understand this important subject which has a direct impact on our health and wellbeing. Food safety is the key to sound health and needs to be in place if citizens of our country are to be protected from food-borne diseases and dietary deficiencies. Just knowledge about nutrition and food science is incomplete without adding the food safety aspect. Keeping this in mind, this new edition has been developed as a comprehensive approach to preparing safe and nutritious food for all.

Like every decade, there have been major changes in the Indian consumer's lifestyle and eating habits. Likewise, the incidence of lifestyle related diseases and consumption of junk food is on the increase, making it necessary for all food business operators and homemakers to understand and apply the basic principles underlying preparation of products that are safe, nutritionally sound, and high in quality. The important role played by regulatory agencies has become more significant and now food business operators are realizing the benefits of adopting food standards and regulations in marketing their products and services.

The aim of this text has been and remains the same—to provide students with a wide range of basic principles and practices in the subject area, thus enabling them to apply their knowledge efficiently—be it at home, in the food industry, hospitality or health care sector, and provide safe, wholesome, and quality food.

About the Book

Although the first edition was initially designed both as an introduction to the subject and as a textbook for students pursuing degree in Hotel Management and Catering Technology, it was well accepted by students and faculty members from food technology, home science, and health sciences. Based on feedback from faculty members, a need to expand the coverage of the book was felt. Therefore, the book now becomes a complete and exhaustive textbook for students from other related streams as well.

Two new chapters and many new topics have been added to ensure adequate coverage of latest trends and make the book useful for students pursuing a course in food science, home science, and hospitality studies.

In addition, 12 original chapters have been revised to include the latest examples and trends in the food and beverage industry. Illustrations have been updated and augmented to add interest to the text.

As in the last edition, each chapter in the book is designed with a focus on the learning objectives. Key terms are explained at the end of every chapter. Simple illustrations, formulae, and reactions are added to portray concepts. Review questions are listed at the end of each chapter. A concise summary to highlight the main points is given for every chapter.

Key Features

- Completely matches the National Council for Hotel Management & Catering Technology (NCHMCT) syllabus for the subjects taught in the first three semesters namely food science, nutrition, and food safety
- Covers subjects taught in hospitality and hotel administration, food technology, applied sciences, home science, and nursing courses
- Provides ample examples, review questions, analytical thinking exercises, and updated reference charts and tables
- Instructors manual with MCQs for all chapters

New to the Third Edition

Based on changing trends in hospitality and food business operators as well as the invaluable feedback received from reviewers, users, industry professionals, and academicians, this edition now includes the following:

- A complete section in the book focuses on all aspects of food safety covered in four dedicated chapters as well an appendix on First Aid.
- Chapter 10 on Food Microbiology introduces the reader to microorganisms that are of significance to the food industry. Both useful and harmful microbes that are of special importance to the food industry, factors that affect and control the growth of microorganisms. An introduction to hygienic handling measures of food items to prevent contamination, spoilage and spread of foodborne disease, emerging pathogens.
- Chapter 11 on Food Processing and Preservation is based on shelf-life, spoilage and contamination, objectives of processing, methods of preservation, effect of processing on nutrients, and food additives.
- Chapter 12 on Food Safety covers principles of safe food, GHP, GMP, hygiene of the food establishment, FSMS guidelines, good habits, 7 C's of food hygiene, common faults in food preparation and service, and food allergies.
- Chapter 13 on Food Standards, Regulations, and Quality Management includes the following topics—international and national regulations and standards, compulsory and voluntary laws and standards—CODEX, ISO, BIS, Agmark; regulatory agencies—National —FSSAI, EIC, QCI, CPA, REGULATORY AGENCIES—International—WHO, FAO, WTO, quality management systems—TQM, FSMS, HACCP; food fortification, genetically modified foods, food labelling.

Extended Chapter Material

The following additions have been made in the existing chapters:

- Chapter 4 on Proteins has a new section on protein isolates, concentrates, and hydrolysates.
- Chapter 6 on Fats and Oils includes trans fatty acids, interesterification, and fat replacers.
- Chapter 10 on Food Microbiology includes classification of hazardous contaminants, mode of spread of food borne pathogens, and emerging pathogens.
- Chapter 11 on Food Processing and Preservation includes classification of food on the basis of its shelf-life.
- Chapter 14 on Introduction to Nutrition has the latest 'recommended dietary allowances' table.
- Chapter 16 on Proteins in Nutrition has introduced the concept of limiting amino acids.
- Chapter 17 on Lipids has a new topic on non-communicable diseases (NCDs).
- Chapter 19 on Vitamins includes absorption of vitamins.
- Chapter 20 on Minerals includes bioavailability of minerals and Selenium.
- Chapter 22 on Balanced Diet includes modifications in the healthy food plate.
- Chapter 24 on Modified Diets has two additional dietary guidelines for cancer patients and Naturopathy.
- Chapter 25 on New Trends in Foods has additional information on new packaging options, safety concerns regarding plastics, and smart packaging.

Coverage and Structure

The text is divided into three sections: (1) food science, (2) food safety, and (3) nutrition.

Section 1—Food Science

The section on food science now comprises nine chapters that cover scientific principles and their applications in the preparation of food and commercial food products. New commodities and processes which are of relevance have been included. This section concentrates on the composition, structure, and behaviour of food in relation to pre-preparation, cooking, packaging, and storage relevant to catering operations.

Chapter 1 introduces students to the basic concepts of food science.

Chapter 2 is on Colloidal systems in foods and explains various colloidal systems encountered in foods and their effect on food quality.

Chapter 3 introduces the student to Carbohydrates and types of cereals and cereal products that are available in the market.

Chapters 4 on Proteins explains pulses to be a vegetarian source of protein and the effect of steeping, sprouting, and cooking on pulses.

Chapter 5 on Fruits and Vegetables discusses the structure and natural plant pigments as well as the role of plants in human diet, various kinds of fruits and vegetables, as well as the structure and natural plant pigments present in them.

Chapter 6 on Fats and Oils discusses concepts such as rancidity, reversion, refining, winterization, and nuts and oilseeds.

Chapter 7 on Flavour explains the various aspects as well as the use of flavours in food preparation and different spices and herbs.

Chapter 8 on Browning Reactions discusses types of browning reactions and the role of browning in food preparation.

Chapter 9 covers different methods of food evaluation.

Section 2—Food Safety

This section comprises four chapters covering all aspects of Food Safety.

Chapter 10 introduces the reader to microorganisms of significance to the food industry.

Chapter 11 on Food Processing and Preservation discusses the objectives of food processing, methods of food preservation, and the effect of processing on food constituents.

Chapter 12 is on Food Safety.

Chapter 13 deals with Food Standards, Regulations, and Quality Management.

Section 3—Nutrition

The section on nutrition comprises 12 chapters related to nutrients and planning of diets for sustaining a healthy lifestyle. Crucial issues such as weight control, eating disorders, and lifestyle-related diseases are included in this section. Dietary guidelines for prevention of deficiency and problems related to excessive consumption have been covered.

Chapter 14 introduces readers to the concept of nutrition.

Chapter 15 on Carbohydrates in Nutrition covers the classification as well as dietary sources of carbohydrates.

Chapter 16 on Proteins in Nutrition introduces students to classification and functions of proteins.

Chapter 17 on Lipids covers fatty acids, antioxidants, saturated fatty acids, cholesterol, and more.

Chapter 18 explains the various functions of water as well as the concept of water balance.

Chapter 19 discusses the various types of vitamins.

Chapter 20 discusses the classification and general functions of minerals.

Chapter 21 on Energy Metabolism covers forms of energy, energy requirements, and energy balance.

Chapter 22 discusses the various aspects of a balanced diet, planning balanced diets, various food pyramids, and the latest concept of the food plate.

Chapter 23 introduces students to menu planning and mass food production.

Chapter 24 on Modified Diets discusses diet therapy and various types of modified diets.

Chapter 25 discusses new trends in foods and nutrition including the nutritional evaluation of new products and highlights different nutraceuticals, such as prebiotics and probiotics, and their role in maintaining health and the significance of nutritional labelling.

Sunetra Roday

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Feedback on this book can be shared with me at sunetraroday@gmail.com.

Preface to the First Edition

The provision of food and beverages is one of the oldest services associated with the hospitality industry. The food services industry has evolved and has come full circle. The need for providing nutritious meals for balanced overall development has acquired greater significance in the past few decades.

Eating out is no longer the occasional special event to be celebrated where people indulge. It has become a way of life. We are forced to eat out or order take-away meals due to work patterns, education, or social commitments. The number of people depending on food service providers for meeting their daily nutritional requirement is increasing at a rapid pace, making it necessary for professionals in the hospitality sector to be able to offer healthy choices on the menu to the customers.

Food science and nutrition has gained added significance with an increase in the number of lifestyle-related diseases, such as high blood pressure, atherosclerosis, heart diseases, diabetes mellitus, and obesity. Food manufacturers are introducing new products keeping these diseases in mind. A need was felt for a book designed specially for students in hospitality-related courses that addresses all the basic issues of food science and nutrition. Keeping this aspect in mind, I decided to write this book.

Food Science and Nutrition is designed both as an introduction to the subject and as a textbook for 'Principles of Food Science and Nutrition' for students of the 'B.Sc. in Hospitality and Hotel Administration' course offered by the National Council for Hotel Management and Catering Technology, New Delhi.

The students who join catering courses have little or no background in food science. They need a textbook that relates to what they practice in practical sessions. They find science difficult to comprehend and time-consuming to study.

From my experience of teaching the subject to students of catering, I have developed a text that concentrates on those aspects of food science and nutrition of particular relevance to the catering industry.

The text is divided into two sections: (1) food science and (2) nutrition.

The section on food science comprises 11 chapters that cover scientific principles and their applications in the preparation of food and commercial food products. New commodities and processes which are of current relevance have been included. This section concentrates on the composition, structure, and behaviour of food in relation to pre-preparation, cooking, packaging, and storage relevant to catering operations.

The section on nutrition comprises 12 chapters pertaining to nutrients and planning of diets for maintaining good health throughout the life cycle. Weight control, eating disorders, and lifestyle-related diseases are included. Dietary guidelines for prevention of deficiency and problems related to excessive consumption have been covered.

Each chapter in the book is designed with a focus on the objectives. Key terms are explained at the end of the chapter. Simple illustrations, formulae, and reactions are added to portray concepts. Review questions are listed at the end of each chapter. A concise summary to highlight the main points is given for every chapter.

Today's consumers ask questions about the nutritional value and health benefits of food. They are aware of the role the diet may play in maintaining and promoting good health. This makes it imperative for the food service provider to understand the fundamentals underlying food science and nutrition and put theory into practice.

Reader's views and comments are most welcome and will be appreciated.

Sunetra Roday

Features of the Book

LEARNING OBJECTIVES

After reading this chapter, you should be able to

- appreciate the importance of food science to a caterer in the context of the processed food revolution
- understand the relationship of food science to food chemistry, food microbiology, and food processing
- appreciate the role of convenience foods in our day-to-day life
- appreciate the importance of understanding the basic concepts in physics, chemistry, and biology
- understand the applications of these concepts in the food industry
- interpret the weights and measures in recipes
- weigh and measure ingredients accurately

Learning Objectives
Each chapter begins with learning objectives that focus on learning and the knowledge you should acquire by the end of the chapter.

Well-labeled illustrations
Each chapter is interspersed with numerous illustrations that supplement the explanation in the text.

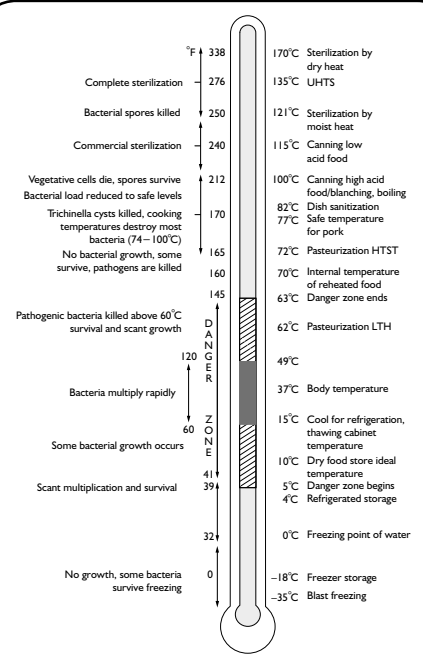


Fig. 11.1 Temperatures used in the food industry and their effect on microorganisms

Tables
All chapters contain tables that provide an outline of the topics discussed in the chapter.

Table 16.5 Recommended protein allowances for Indians

Group	Particulars	Body weight (kg)	Protein (g/day)
Man	Adult	60	60
Women	Adult	55	55
	Pregnancy		+23
	Lactation (0–6 months)		+19
	(6–12 months)		+13
Infants	0–6 months	5.4	1.16 g/kg
	6–12 months	8.4	1.69 g/kg
Children	1–3 years	12.9	16.7
	4–6 years	18	20.1
	7–9 years	25.1	29.5
Boys	10–12 years	34.3	39.9
	13–15 years	47.6	54.3
	16–18 years	55.4	61.5
Girls	10–12 years	35	40.4
	13–15 years	46.6	51.9
	16–18 years	52	55.5

SUMMARY

Vitamins are vital organic compounds required by the body to perform specific functions such as the release of energy from food and other growth related, protective and regulatory functions. They are required in minute amounts and hence are categorized as micronutrients. They are broadly classified as fat soluble (vitamin A, D, E, and K) and water soluble (B-complex and vitamin C) vitamins. Each vitamin has a specific role to perform and cannot be replaced by another vitamin. Fat-soluble vitamins require fat for their absorption and can be stored in the body. Water-soluble vitamins are readily absorbed but are not stored in the body. Excessive intake of fat-soluble vitamins leads to toxicity or hypervitaminosis.

Vitamin A is present in animal foods only. Carotene, a [illegible] is rarely seen in adults as both vitamins are wide-spread in nature.

The B-complex vitamins are water soluble and include eight vitamins, namely thiamine or B_1, riboflavin or B_2, niacin, pyridoxine or B_6, folic acid, cyanocobalamine or B_{12}, pantothenic acid, and biotin. They mainly function as co-enzymes in the release of energy from carbohydrates, fats, and proteins. Three B-complex vitamins are designated 'anaemia preventing vitamins' as they are needed for synthesis of haeme and for the maturation of red blood cells. Apart from the food sources, the bacterial flora in the intestine are capable of synthesizing vitamins, namely vitamin K and B-complex vitamins.

Summary
The summary at the end of each chapter draws together the main concepts discussed within the chapter. This will help you to reflect and evaluate important concepts.

Exercises
Each chapter contains a series of exercises that enhance learning and can be used for review and classroom discussion.

REVIEW EXERCISES

1. Why does a food handler need to have knowledge about food microbiology?
2. Classify the different microorganisms which are present in our food.
3. Discuss the beneficial effects of microorganisms.
4. Explain the terms cross-contamination, sanitation, foodborne illnesses, and danger zone.
5. Differentiate between food poisoning and food infection.
6. List the various factors which affect microbial growth and explain any two factors.
7. Define the following terms:
   (a) Anaerobes (c) Thermophiles
   (b) Infestation (d) Saprophytes
   (e) Contamination (g) High-risk foods
   (f) Endospores
8. With the help of a line diagram, explain how diseases are transmitted directly and indirectly.
9. Discuss the harmful effects of microorganisms with respect to food spoilage and foodborne illnesses.

Fill in the blanks

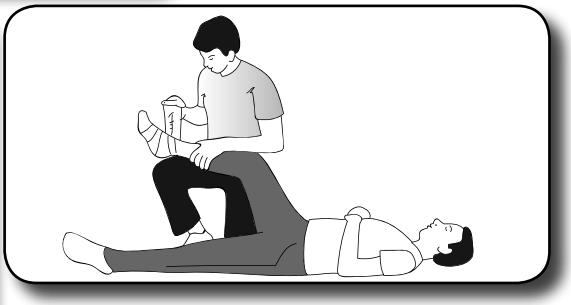
1. Dietary fibre provides _____ kcal/g of energy.
2. The human body stores carbohydrate in the form of _____ in the muscles and liver.
3. The water-soluble fibre _____ is used for setting jams and jellies.
4. The sugar _____ is present in the blood stream.
5. The hormone _____ secreted by the _____ regulates blood sugar levels.

Give one word for the following

1. Disease caused due to insufficient insulin
2. Elevated blood glucose levels
3. Disaccharide made up of glucose and galactose
4. Dietary fibre that is not a carbohydrate
5. Blood level of a substance at which it cannot be reabsorbed by the kidneys

7. Match the following minerals in column I with a deficiency symptom in column II.

I	II
(i) Calcium	(a) Tooth decay
(ii) Iron	(b) Cretinism
(iii) Sodium	(c) Muscle cramps
(iv) Iodine	(d) Alkalosis
(v) Fluorine	(e) Spoon-shaped nails
(vi) Chloride	(f) Macrocytic anaemia
(vii) Phosphorus	(g) Osteoporosis
	(h) Glossitis
	(i) Tetany
	(j) Night blindness



Appendix
Appendix A at the end of the book provides information on First Aid techniques used in different situations such as heart attack, accident, etc.

Brief Contents

Detailed Contents

PART III NUTRITION

1 Introduction to Food Science

LEARNING OBJECTIVES

After reading this chapter, you should be able to

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- appreciate the role of convenience foods in our day-to-day life
- appreciate the importance of understanding the basic concepts in physics, chemistry, and biology
- understand the applications of these concepts in the food industry
- interpret the weights and measures in recipes
- weigh and measure ingredients accurately

INTRODUCTION

The food industry, be it the processing industry or the catering industry, is one of the largest and most needed industries in the world today fulfilling one of our three basic needs, i.e., food. Its growth rate is phenomenal, growing by leaps and bounds to provide three square meals to our rapidly increasing population and keeping pace with the ever-changing demands of the people.

The developments in the food industry can be traced back to surplus food which needed to be preserved for a rainy day. Food preservation is not a new phenomenon. Our forefathers understood the basic principles underlying food preservation and practised them using natural ingredients and the forces of nature, such as sunlight and ultraviolet (UV) rays, till newer and more scientific methods were developed.

Improvement in equipment and machinery has made it possible to increase the capacity of food processing plants greatly. The shelf life of perishable foods has increased dramatically with the invention of the refrigerator and the use of dry ice.

With the advent of the wheel, surplus food was transported several hundred miles. As early as in 1850, milk was transported by special milk trains and tank trucks over a distance of several hundred miles with negligible loss in quality. Food, which was perishable, was moved thousands of miles before it was processed, stored, and consumed.

Over the past few decades, the food industry has witnessed a significant change. The market has witnessed a flood of food commodities, superior in quality and available all year round. Ice cream filled cones and nuts in ice cream retaining their crunch, fresh milk stored on the shelf for months, and crisp croutons in a ready to serve cream soup are a few marvels of food science and technology. With these advances in science and technology, the consumer has an unlimited choice of meals to choose from all year round.

The aesthetic value of food is important. To be able to offer the consumer quality cuisine, basic knowledge of food science and its applications is necessary. Every food handler should know the composition, structure, and behaviour of food and the changes that take place during cooking, holding, and storage as well as what happens to the food once it is consumed, i.e., its digestion, absorption, and metabolism in the human body.

The study of food is today accepted as a separate discipline called food science.

Definition Food science is a systematic study of the nature of food materials and the scientific principles underlying their modification, preservation, and spoilage.

To understand food science, it is necessary to understand the basic concepts of physics, chemistry, mathematics, and biology and their applications, i.e., biochemistry, microbiology, and food technology, in order to prepare, package, store, and serve wholesome, high quality products.

All foods are chemical compounds which undergo various chemical reactions at all stages from production to consumption. These reactions are based on the laws of chemistry. Many processes used while preparing food involve physical changes apart from chemical changes.

Matter exists in three states—solid, liquid, and gas. In general, as the temperature is increased, a pure substance will change from solid to liquid and then to gas, without change in chemical composition. However, many organic compounds will decompose, undergoing various chemical reactions, rather than a change of state when temperature is raised.

Many foods are complex mixtures of chemical substances. In processed foods, additives are added to improve colour, texture, flavour, etc., and these additives are also chemical compounds. It undergoes further chemical changes during storage, cooking, processing, as well as in the human body during digestion of food by action of chemical substances.

Physical aspects of food such as the various food systems are of colloidal dimensions. Food is subjected to various physical conditions during preparation and storage which affect its quality such as temperature and pressure changes.

INTER-RELATIONSHIP BETWEEN FOOD CHEMISTRY, FOOD MICROBIOLOGY, AND FOOD PROCESSING

Food chemistry is the science that deals with the composition, structure, and properties of food, and with chemical changes that take place in food. It forms a major part of food science and is closely related to food microbiology. The chemical composition of food dictates which microorganisms can grow on it and the changes which take place in the food because of their growth. The changes may be planned and desirable or may result because of contamination, causing disease, i.e., causing food poisoning and food infection or just spoiling the food rendering it unfit for consumption. Microorganisms have basic growth requirements, namely food, moisture, temperature, time, osmotic pressure, pH, and the presence or absence of oxygen.

Food chemistry and food microbiology are intimately related to food processing because the processes to which food needs to be subjected to improve its taste, texture, flavour, and aroma depend on its composition and ingredients. The time and temperature for food processing depend not only on the chemical composition of food but on its microbial load and the type of packaging to be used.

The growing public demand for meals away from home has made the problem of serving safe wholesome food more critical and challenging. This makes it imperative for food handlers to understand and implement the basic principles of food science to enable them to prepare and serve high quality products over extended meal hours.

NEED FOR CONVENIENCE FOODS

Rapid urbanization and changes in social and cultural practices have modified the food habits of the community. Industrial development in Indian cities has compelled labour from villages to migrate to cities in search of employment. It is estimated that within the next five years, half the world's population will be living and working in urban areas. Increase in buying power and long hours spent away from home commuting to work places, make convenience foods a necessity in every home.

The ever-increasing market for convenience foods, be it tinned, canned, chilled, frozen, or preserved, presents a whole array of complex operations in food processing. This weaning away from the traditional fare of yesteryears provides a tremendous and urgent challenge to the food industry—serving safe, attractive, and nutritious food that is wholesome and bacteriologically safe, at the same time conforming with quality standards.

The urban workforce does not have the time or inclination to follow the traditional recipes and prefers picking up packed, clean, and reasonably priced meals rather than returning home from work and doing domestic chores.

Most food consumed in developed countries is in the form of *convenience foods*. Convenience foods are foods that require little labour and time to prepare. A packet of frozen green peas is a convenience food since it requires no shelling. A packet of whole wheat flour is also a convenience food as it has already been milled. A packet of instant idli mix is more of a convenience food; with 'ready to eat' or 'heat and eat' foods, such as chicken *keema matar* or canned *palak paneer*, are most convenient since they need no further cooking.

Many different types of convenience foods are available in the market today. The speed and efficiency of cooking and service increases dramatically with the use of convenience foods, giving the caterer, homemaker, or working professional more time to devote to other activities. The convenience food revolution is possible because of a wide variety of chemicals which are added to food not only to preserve it but to enhance its overall quality. These numerous chemicals, tested and permitted by law to be added to food, are called *food additives*.

Today, convenience foods are being specially packed for caterers and are available in large catering packs. Manufacturers of specialized food supplies pack food so that it fits into standard catering equipment, e.g., catering packs that fit into vending machines. The caterer can choose between smaller packs or larger packs that are economical.

Convenience foods need to be handled with care because one source of infection can contaminate thousands of pre-packed items. Take-away meals should not be kept for a long time, hygiene should be practised in processing plants, and time and temperature control should be observed during storage. Leftover contents in large catering packs should not be stored in the open.

Convenience foods help by saving considerable time and effort. However, the cost of convenience foods compared to home-prepared foods should be considered before purchase. Some foods may not be costlier while others may work out to be expensive. For people who have to rush home from work and prepare a meal, such foods purchased on the way home or stacked in the deep freezer are not only time-saving but also convenient.

Convenience foods vary widely in their palatability, nutrient content, and cost. The consumer can choose from a bewildering display of snacks, soups, sauces, fruit chunks and juices, desserts, meat, and vegetable preparations and gravies in the ready-to-eat and ready-to-cook form. Some only need to be warmed up in a microwave oven before they are served.

Canned foods, commercially prepared chapattis, snacks both sweet and savoury, main course, vegetable preparations, soups, gravies, sauces, breakfast cereals, bakery items, deep frozen foods, dry ready mixes, etc., are not only time saving but convenient to cook and store as well.

Thus, food science covers all aspects of food, from the properties of food materials and influences of all factors affecting food, beginning from growing the food to harvesting or slaughter, i.e., all stages from the farm to the table, from raw food till it is consumed such as processing, nutritive value, shelf life, novel sources of food, fabricated food and food analogs, conservation and reuse of resources to make more food.

A study of food science, food safety, and nutrition will be of benefit to all food professionals.

Let us begin by understanding the basic concepts of food science.

FOOD SCIENCE CONCEPTS

Food science concepts are discussed in the following sections.

BASIC SI UNITS OF LENGTH, AREA, VOLUME, AND WEIGHT

Weights and measures are set standards which are used to find the size of substances. To obtain a high-quality product and carry out a profitable business, accurate weighing and measuring of all ingredients is essential.

The SI or International System of measurement is used universally for measurement of matter. In this system, prefixes such as 'deci', 'centi', and 'milli', and units such as 'litre', 'gram', 'metre', and derived units such as 'joule' and 'pascal' are used.

Prefixes represent numbers or numerical quantities symbolized by letters.

mega = M = 1,000,000 = one million	centi = c = 1/100 = one hundredth
kilo = k = 1,000 = one thousand	milli = m = 1/1,000 = one thousandth
deci = d = 1/10 = one tenth	micro = μ = 1/1,000,000 = one millionth

Measurement of Length

The unit for measuring length is the metre (m).

Length is measured using a measuring tape or ruler.

One thousand metres (1,000 m) = one kilometre (km)

A metre is divided into hundred parts. Each part is called a centimetre (cm).

1 metre (m) = 100 centimetres (cm)

Each centimetre is made up of ten smaller parts called millimetre (mm).

1 centimetre = 10 millimetres (mm)

The simplest instrument for measuring length is a scale/ruler measuring one metre, or a measuring tape.

Measurement of Volume

Volume and capacity is measured in litres. A litre is made up of 10 decilitres (dl). Each decilitre is made up of 10 centilitres (cl). A centilitre is made up of 10 millilitres (ml), which means that a litre is made up of one thousand millilitres (1,000 ml).

Most measuring cups and jugs are marked in millilitres and litres. The capacity of cups and spoons is listed below.

1 tablespoon = 15 ml	1 coffee cup = 100–120 ml
1 teaspoon = 5 ml	1 teacup = 150–180 ml
1 breakfast cup = 240 ml	1 water glass = 280–300 ml

The volume of solids that is not greatly affected by water can be measured by the water displacement method. Solids are immersed in the displacement can and the volume of water displaced, equal to the volume of the solid, is noted.

The seed method is used to measure the volume of cake and bread. A large tin box is filled to the brim with seeds and the volume of seeds required to fill the box is measured in a measuring cylinder. The cake, whose volume is to be measured, is placed in the empty tin and covered with seeds. The volume of seeds remaining after covering the cake is equal to the volume of the cake.

Measurement of Weight or Mass

Weight is the pull experienced on the body by the earth's force of gravity. Mass is the amount of matter contained in a known volume of substance. Mass always remains constant but weight may change in different parts of the world because the force of gravity varies from place to place.

Weight is measured on a weighing scale (see Fig. 1.1). The kilogram is the unit for measuring weight and is made up of one thousand smaller parts called grams.

1 kilogram (kg) = 1,000 grams (g)

Each gram is further divided into one thousand smaller parts called milligrams (mg).

1 g = 1,000 mg

Each milligram is further divided into 1,000 micrograms (μg).

1 mg = 1,000 μg

From the above we conclude that

1 kg = 1,000,000 mg and a measure of 1 ppm means 1 mg in 1 kg of a substance.

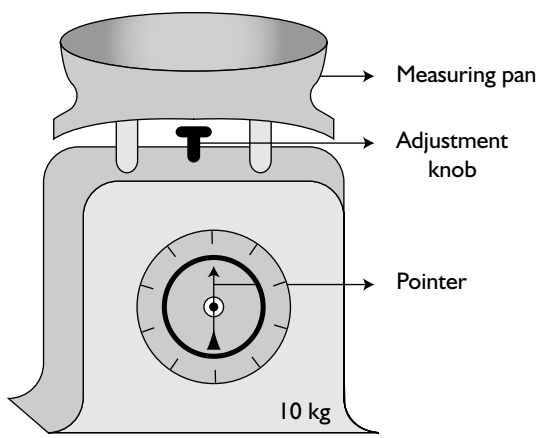


Fig. 1.1 Single pan weighing scale

DENSITY

Density is the relationship between the weight and volume of a substance expressed as

$$\text{Density} = \frac{\text{weight in kg}}{\text{volume in m}^2}$$

It is expressed in kilograms per cubic metre and is used to compare the heaviness or lightness of different foods.

A fruit cake has a greater density as compared to a sponge cake. The density of liquids is measured in g/cm^3. Water has a density of 1 g/cm^3.

Relative Density

Relative density (RD) is the ratio of the mass of a known volume of a substance to the mass of the same volume of water. It tells us the number of times the volume of a substance is heavier or lighter than an equal volume of water. If the RD of a volume of lead is 11, it means that it is eleven times as heavy as an equal volume of water.

$$\text{Relative density} = \frac{\text{mass or weight of a substance}}{\text{weight of equal volume of water}}$$

A hydrometer is used to measure the relative density of different liquids. It is made up of a weighted bulb with a graduated stem calibrated to measure the relative density of the liquid directly. The liquid is kept at room temperature and the hydrometer is allowed to float in the liquid. The depth to which it sinks is read on the graduated stem. Hydrometers are specifically calibrated to measure the RD of different liquids used in the catering industry.

Saccharometers are used to determine the concentration of sugar solutions, denoted in degrees Brix. A 75 per cent sugar solution is called 75 degrees Brix.

Salinometers are used to determine the RD of brine or sodium chloride solutions used for canning vegetables or pickling ham.

Lactometers are used for checking the purity of milk. Addition of water or removal of cream affects the RD and is depicted on the graduated scale on the stem. The scale is marked 1.00 to 1.04. 'W' denotes RD of water, 'M' denotes pure milk, and 'S' denotes skim milk.

Alcoholometers are used to test the RD of alcoholic beverages. It is used to check the number of degrees proof or ethanol content of wines, beers, and spirits, and whether it has been diluted.

Refractometers (see Fig. 1.2) are used to measure the sugar or total solids in solution (TSS) while preparing jam, syrups, etc. They measure the refractive index of light reflected through the solution.

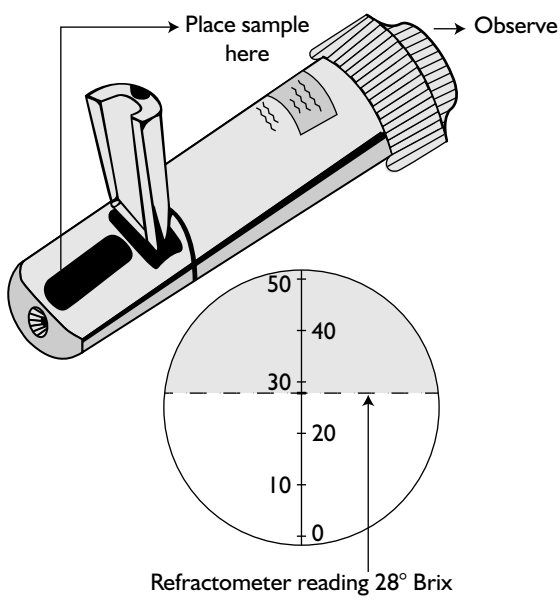


Fig. 1.2 A refractometer

Besides checking the purity of milk, ethanol content of alcoholic beverages, strength of salt solution, and concentration or stage of 'doneness' for sugar syrups and preserves such as jam, sauce, and candied fruit, the other applications of RD are

- testing eggs for freshness when eggs are dipped in a 10 per cent salt solution, fresh eggs sink and stale eggs float because of a large air space caused by staling;
- determining the lightness of cakes; and
- choosing potatoes for boiling and frying. Potatoes that have a low RD should be boiled, while those that have a high RD should be baked or fried.

TEMPERATURE

Heat is a form of energy needed to carry out work. Energy is the capacity for doing work. Energy is present in two forms:

1. Potential energy or stored energy, such as the energy stored in a bar of chocolate
2. Kinetic energy or active energy in motion, such as when a person is walking

Energy is present in many forms. Heat is one form of energy. Solar energy, electrical energy, and chemical energy are some of the others.

Heat energy is measured in units called joules and the energy present in food is measured in kilocalories. One kilocalorie is made up of 1,000 calories.

1 kilocalorie (kcal) = 4.2 kilojoules (kj)

1 calorie = 4.2 joules

Temperature refers to the relative hotness or coldness of a substance compared with melting ice at 0 °C and boiling water at 100 °C. Thermometers are used to measure temperature.

Temperature is measured either in the Celsius or centigrade scale (°C) or in the Farenheit scale (°F). Each scale has two fixed points:

1. Melting point of ice (0 °C or 32 °F)
2. Boiling point of water (100 °C or 212 °F)

The Celsius scale is divided into 100 degrees and the Farenheit scale into 180 degrees. The Celsius scale is the international scale.

Conversion of Farenheit Scale to Celsius Scale

To convert temperature in °F into °C, the following formula is used

$$(°F - 32) \times \frac{5}{9} = °C$$

To convert 212 °F into °C

$$(212\,°F - 32) \times \frac{5}{9} = \cancel{180}^{20} \times \frac{5}{\cancel{9}_{1}} = 20 \times 5 = 100\,°C$$

so

$$212\,°F = 100\,°C$$

Conversion of Celsius Scale to Farenheit Scale

To convert temperatures in °C to °F, the following formula is used.

$$°C \times \frac{9}{5} + 32 = °F$$

To convert 37 °C into °F

$$37 \times \frac{9}{5} + 32 = {}^{\circ}\text{F}$$

$$37\ {}^{\circ}\text{C} = 98.6\ {}^{\circ}\text{F}$$

The conversion of imperival units to metric equivalents is given in Table 1.1.

Table 1.1 Conversion of Imperial units to metric equivalents

	Non-metric units	Metric units
Length	1 inch (in)	2.5 centimetres (cm)
	1 foot (ft)	30.5 centimetres (cm)
	39.4 inches (in)	100 centimetres (cm) or 1 metre
	1 mile	1.6 kilometres
Volume	1 pint	568 millilitres (ml)
	1 gallon	4.5 litres (l)
	1.8 pints	1 litre (l)
Weight	1 ounce (oz.)	28.4 grams (g)
	1 pound (lb)	454 grams (g)
	2.2 pounds (lb)	1 kilogram (kg)
Energy	1 kilocalorie (kcal)	4.2 kilojoules (kJ)
	1 calorie (cal)	4.2 joules (J)
Temperature	32°Fahrenheit (F)	0°Celsius (C)
	212°Fahrenheit (F)	100°Celsius (C)
Area	1 square inch (sq. in)	6.45 square centimetres (sq. cm)
	1 square foot (sq. ft)	929 sq. cm
	1 square mile	2.59 sq. km

TYPES OF THERMOMETERS

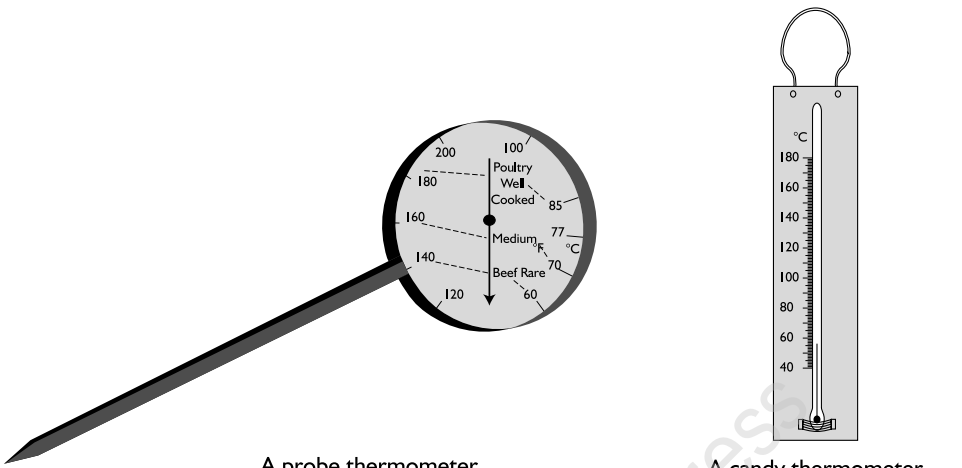
Most thermometers (see Fig. 1.3) are mercury in glass thermometers with different temperature ranges depending on their purpose. Some common thermometers are listed below:

1. Sugar or confectionery thermometers (40 °C to 180 °C)
2. Dough testing thermometers (10 °C to 43 °C)
3. Meat thermometers with a special spike which can be pierced into meat and a round dial to record temperature, also called probe thermometers
4. Refrigeration thermometers filled with red coloured ethanol (–30 °C to –100 °C)

POTENTIAL HYDROGEN or pH

When an acid is diluted with water, it dissociates into hydrogen ions and acid radical ions.

$$\underset{\text{Hydrochloric acid}}{HCl} = \underset{\text{Hydrogen ion}}{H^+} + \underset{\text{Chloride ion (acid radical)}}{Cl^-}$$



A probe thermometer
(meat thermometer)
stainless steel body
glass dial

A candy thermometer
(sugar thermometer)
glass thermometer
fitted on brass 40 °C to 180 °C

Fig. 1.3 Thermometers

The term pH (hydrogen ion concentration) is used to express the degree of acidity or alkalinity of a food. It is defined as the negative logarithm to base 10 of the hydrogen ion concentration, i.e., higher the hydrogen ion concentration, lower will be the pH and vice versa. Some foods, such as fruits, contain organic acids and have an acid reaction while others such as milk are neutral. Bakery products leavened with baking powder, have an alkaline reaction. Pure water is pH 7 or neutral.

The pH scale of pH 0 and pH 14 (see Fig. 1.4), i.e., from extremely strong acids to extremely strong alkali is used to describe the acidity or alkalinity of food.

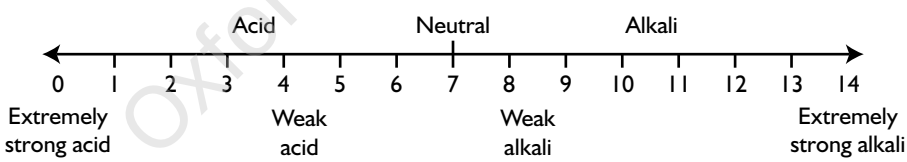


Fig. 1.4 The pH scale

A reading between pH 1 and pH 6.5 indicates acidic food while between pH 7.5 and pH 14 indicates alkaline food (see Table 1.2). The pH of a solution can be measured electrically using the pH meter or it may be measured colorimetrically using pH papers which change colours according to the pH.

Table 1.2 pH values of some common foods

pH	pH value	Food
Strongly acidic	2.0	Vinegar
	2.3	Lime juice
	2.7	Pickles
	3.0	Apples
	3.7	Orange juice

Contd

Table 1.2 Contd

pH	pH value	Food
	4.0	Fruit cake
	4.3	Tomato
	4.6	Banana
	5.0	Bread
Mildly acidic	5.4	Spinach
	5.5	Potatoes
	6.0	Peas
	6.2	Butter and Chicken
	6.4	Salmon
	6.5	Milk
Neutral	7.0	Chocolate
Mildly alkaline	8.0	Egg white
	9.0	Soda bread

When hydrogen ions (H^+) or hydroxide ions (OH^-) are added, they can be absorbed by these systems without altering the pH of the resulting solution.

Common buffers are of two types:

1. Acetic acid and sodium acetate mixture
2. Citric acid and sodium citrate mixture

Buffering action is very important in the human body and in food. The salts of calcium, phosphorus, sodium, and potassium function as buffers and maintain the pH of milk at a constant level of 6.5.

Applications of pH

1. Preparation of jam—The pectin in jam and marmalade does not form a gel until the pH is lowered to 3.5. If fruit used for making these preserves does not contain sufficient acid, small amounts of citric acid should be added.
2. Retaining bright green colour in green vegetables—Green vegetables tend to get discoloured when cooked. Green colour can be retained by adding a pinch of sodium bicarbonate to the cooking liquor but B complex vitamins and vitamin C gets destroyed in an alkaline medium.
3. Food digestion—pH of the gastrointestinal juices affects our digestive process. The pH of gastric juice is strongly acidic, between 1 and 2, and aids in digestion of food in the stomach while a mildly alkaline pH, between pH 7 and pH 8, is needed to complete digestion in the intestine.
4. Texture of cakes—A significant change in texture is observed with a change in pH while baking cakes. Low pH gives a fine texture and high pH gives a coarse texture to the cake crumb.
5. pH of dough—In bread making, compressed yeast is used for fermentation. During fermentation, yeasts convert simple sugars to ethyl alcohol and carbon dioxide.
   (a) Ethyl alcohol takes up oxygen and forms acetic acid
   (b) Carbon dioxide dissolves partially in water to form carbonic acid
   (c) Chemical yeast food, i.e., ammonium sulfate and ammonium chloride if used produce sulphuric acid and hydrochloric acid, respectively.

All these acids lower the pH of the dough from pH 6.0 to pH 4.5. This change in pH makes the dough less sticky and more elastic.

IMPORTANT TERMINOLOGIES, THEIR DEFINITION, AND RELEVANCE

Boiling Point

Boiling is the use of heat to change a substance from a liquid to a gas. The change takes place throughout the body of the liquid at a definite temperature.

Like the melting point, the boiling point of a pure substance is always constant. It changes if impurities or dissolved substances are present or by changes in atmospheric pressure. Pure water boils at 100 °C.

Applications of Boiling Point

1. Boiling vegetables in salted water increases the boiling point above 100 °C.
2. In sugar cookery, the boiling points of sugar solutions is noted at various stages so that fondant, fudge, toffee, and caramel can be prepared.

Boiling under pressure When atmospheric pressure is lowered, water boils at a lower temperature of 70 °C. At hill stations, the atmospheric pressure is low so temperature is also lower and food takes longer time to cook. When pressure is increased, e.g., below sea level or boiling in a pressure cooker, water boils at higher temperatures and cooks food faster.

Applications of Boiling under Pressure

1. Food is cooked in pressure cookers to reduce cooking time to one-fourth of ordinary cooking time as water boils at a higher temperature under pressure.
2. Autoclaves are used for sterilization by moist heat under pressure at 121 °C and 15 lb pressure for 20 minutes (see Fig. 1.5).

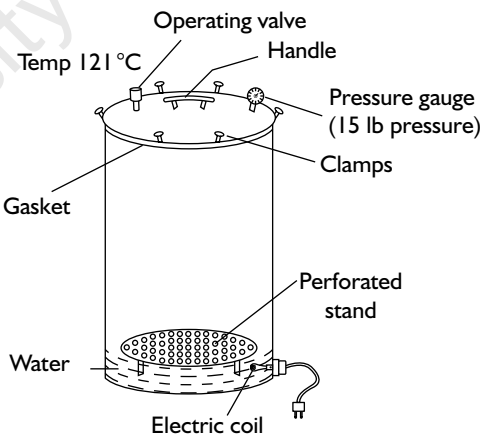


Fig. 1.5 An autoclave

Evaporation

Evaporation is a change of state from liquid to gas which takes place continuously from the surface of a liquid.

Volatile liquids vaporize easily, e.g., petrol and acetone.

Non-volatile liquids, such as oils, evaporate very gradually. Evaporation is faster when there is breeze and low humidity in the air as well as a large surface area and high temperature.

Applications of Evaporation

1. Bread and cake if left uncovered, hardens and becomes stale because of loss of moisture. This can be prevented by storing food in covered tins.
2. Cooking in shallow uncovered pans will cause greater evaporation and are used for preparing mawa from milk.

3. Milk powder is prepared by dehydration or spray drying in which water from milk is removed by circulating hot air.

Melting Point

Melting or fusion is the change of state from a solid to a liquid.

The temperature at which a solid melts and turns into a liquid is called its melting point. The melting point of fats depends on the percentage of saturated long chain fatty acids present in it.

The melting point for any chemical is fixed and is used to measure the purity of a substance. It is lowered by adding other substances.

Melting point of fats	
Vanaspati	37–39 °C
Butter	36 °C
Lard	44 °C
Tallow	48 °C
Coconut oil	26 °C

Applications of Melting Point

1. Ice has a melting point of 0 °C. If adequate sodium chloride is added to ice, the melting point falls to –18 °C. This lowering of melting point is used in the setting of ice cream.
2. Fat is removed from adipose tissue of animals by a process called rendering, which is based on the melting point. Boiling water or dry heat is used to liberate the oil from the fat cells.

Corn oil temperatures	
Frying	180–195 °C
Smoke point	232 °C
Flash point	330 °C
Fire point	363 °C

Smoke point When fats and oils are heated strongly above frying temperature, they decompose and a stage is reached at which it emits a visible thin bluish smoke. This temperature is called the smoke point (see Table 1.3).

Table 1.3 Smoke point of some common fats

Oil	Smoke point (°C)
Corn oil	232
Cotton seed	236
Soya bean	243
Ground nut	243
Butter	201
Lard	222
Beef dripping	163

The temperature varies with different fats and ranges between 160 °C and 260 °C. The bluish vapour is because of the formation of acrolein from overheated glycerol. Acrolein has an acrid odour and is irritating to the eyes. The effect of high temperature on fat is shown in Fig. 1.6.

The smoking point is lowered by the following factors:

1. Presence of large quantities of free fatty acids
2. Exposure of large surface area while heating
3. Presence of suspended food particles

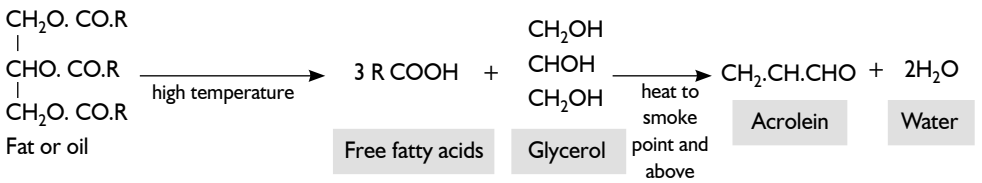


Fig. 1.6 Effect of high temperature on fat

Flash point This is the temperature at which the decomposition products of fats and oils can be ignited, but will not support combustion. The flash point varies with different fats and ranges between 290 °C and 330 °C.

Fire point This is the temperature at which the decomposition products of fats and oils support combustion. It ranges between 340 °C and 360 °C for different fats. The oil or fat may catch fire and burn.

The smoke point, flash point, and fire point are lowered by the presence of free fatty acids.

Normal frying temperature for most oils is 180–195 °C. The smoke point is 25–40 °C above normal frying temperature. The application of smoke point is in frying foods. Fats and oils used for deep fat frying should have a high smoke point. Moist foods should be coated well before frying as moisture present in food tends to hydrolyse the fat and increase the free fatty acids present.

Surface Tension

Surface tension is a force experienced on the surface of a liquid. It is caused by cohesion, i.e., a force that causes the molecules of a substance to be attracted to one another.

The molecules of a liquid that are below the surface are pulled by cohesive forces from all directions. However, the molecules at the surface behave differently because they are only pulled downwards or sideways. This downward or sideways attraction causes a constant pull on the surface molecules which makes the liquid behave as if it is covered by a thin elastic film. For example, the surface of water can support needles if they are placed carefully.

Due to surface tension, drops of liquid take a spherical shape, which has the smallest possible surface area, e.g., dew drops.

Surface tension causes liquids to rise in a thin tube (capillary tube) when the tube is dipped in liquid. This property of liquids is important in many food systems and in the action of detergents.

Surface tension is also defined as the force of attraction which exists between liquid and solid surfaces.

Applications of Surface Tension

1. Addition of detergent to liquids reduces the surface tension of water and the surface attraction between the fibre and greasy stain, and allows the soil to be removed from the fabric.
2. Release agents help prevent the paper lining the tin from sticking to the cake. They contain silicone compounds.
3. Silicones have a property of lowering the surface tension and is added to wood polishes to allow the polish to spread easily.
4. Non-stick cookware is coated with polytetrafluoroethane plastic or silicone to prevent attraction between the food and pan.

Osmosis

Osmosis is the passage of water from a weak solution to a stronger solution through a semi-permeable membrane.

When raisins are soaked in a cup of water for sometime, the raisins swell because water from the cup enters the raisins. Similarly, if raisins are placed in a concentrated sugar solution, they shrivel up after some time because water from the raisins passes into the sugar solution because of osmosis.

Plant and animal cell membranes act as semi-permeable membranes and selectively permit water and electrolytes to enter or leave the cell.

Applications of Osmosis

1. Osmosis plays an important role in food processing and preservation to retain the original shape and size of canned fruits in syrup and of vegetables in pickles.
2. The freshness of fruits and vegetables depends on the osmotic pressure in the cells. Salads lose their crisp crunchy texture and become limp if salt and sugar is sprinkled much in advance. Lettuce leaves can be revived by immersing them in chilled water.

Humidity

Humidity refers to the presence of water vapour in the air. Water vapour is produced by respiration of plants and animals, evaporation from food during cooking and from water bodies, from rain during the monsoons, etc.

In catering establishments, moisture in the air is quite high because of large volumes of steam from boilers, from cooking food, from dishwashers and laundry processes, and respiration and perspiration of people in a confined area.

A humid atmosphere causes discomfort, headache, and tiredness.

The humidity of the air is measured with the help of a hygrometer. This instrument depicts the percentage of water vapour in the air. It is a ratio between the amount of water vapour which air could hold and what it actually holds at the same temperature. Humidity of 60–70 % is considered normal and does not cause discomfort or undue spoilage of food.

Applications of Humidity

1. Spoilage organisms multiply and spores germinate at high moisture levels in the atmosphere.
2. Humidity needs to be controlled in air-conditioned rooms along with ventilation and heating which is done by humidifier water sprays which maintain 60–70 % humidity.
3. Processed foods are prevented from drying up by adding substances with hygroscopic properties called humectants. Glycerine and sorbitol are used as humectants in jam.

FOOD RHEOLOGY

It is the science of measuring forces, which are needed to deform food materials or to study the flow properties of liquid foods. It deals with the viscous behaviour of a system.

Solid food can be chopped up, ground, minced, sliced, torn apart, or broken while it is being prepared or eaten. The texture is determined when we chew food and it is described as crisp, tough, chewy, creamy, sticky, spongy, etc.

Liquid foods are fluid or viscous. Viscosity is defined as the resistance of a liquid to flow. It is measured by an instrument called a viscometer. This property of a liquid is seen in batters, sauces, syrups, etc.

Compression It is the pressure needed to squash foam or spongy foods to find out their freshness or tenderness. The compressimeter or tenderometer is used to measure the lightness of a product.

Adhesion Adhesive gum-like properties give stickiness to food which sticks to the teeth when chewed, such as toffee. Breaking strength of dry foods, such as spaghetti, biscuits, and potato wafers, are measured by applying a load till the product breaks.

Shearing It is the force needed to cut or slice through meat, vegetables, fruits, etc., and indicates the toughness of a food. Penetrometers measure the force needed to penetrate a food such as jelly, cooking fat, canned and fresh fruits, and vegetables.

Rigidity It is the property of those substances which do not flow, e.g., baked custard and cake. Rigid substances show either elastic property or plastic property.

Elastic substances These substances do not flow, but flow when force is applied. However, when the force is removed it regains its original shape, e.g., sponge cake.

Elasticity It is the property which permits a substance to change its shape when a force is applied to it and to come back to its original shape once the force is removed, provided the force applied is within elastic limits.

Applications of Elasticity

1. The stretching power of the dough can be tested before baking. The extensibility of flour is due to gluten formed in flour. Over kneading of dough results in decreased elasticity.
2. Dough improvers are chemicals added to improve or strengthen the elasticity of bread dough.
3. Addition of malt flour gives a softer-textured dough because of the enzymes present in malt.

Plastic substances These substances resist flow to a certain point, but beyond that point they flow, i.e., they become plastic in nature.

Plasticity is an important property of margarine. A plastic fat is one which can be creamed as well as forms a thin sheet or layer in dough when the dough is rolled out, e.g., flaky pastry.

SUMMARY

The food industry is a fast-growing industry that applies the principles of food science and technology to offer the consumer a wide array of fresh and processed foods to meet their nutritional needs, wants, and budget. These foods are available under different brand names, all year round in delectable flavours and assorted preparations. The aesthetic value of food is an important criterion in its acceptability. Every food handler should be aware of the composition, structure, and behaviour of food and what happens to it during processing and after consumption. The systematic study of food is called food science. All foods are chemical compounds and undergo physical as well as chemical changes. The various food systems are of colloidal dimensions and various physical conditions, such as temperature and pressure, affect its quality.

Food science is intimately related to food chemistry, food microbiology, and food processing. To understand this, the basic concepts of physics, chemistry, mathematics, and biology are necessary.

The growing demand for meals away from home has made the problem of serving safe and wholesome food critical and challenging. There is a shift in focus from

farm-grown fresh foods to partially or totally processed convenience foods. These foods require little labour and time to prepare and are useful to caterers and homemakers. The shelf life and acceptability of these foods are enhanced by the use of permitted additives.

A knowledge of basic physical, chemical, and biological sciences is needed by all students studying catering. Today, the SI or International System of measurement is used universally for measuring matter. The unit for measuring length is the metre and for volume, it is the litre. Weight is measured in kilograms and may change from place to place because of the force of gravity or the pull of the earth. The hydrometer is used to measure the relative density of different liquids and is specifically calibrated to measure the relative density of different substances. The lactometer is used to test the purity of milk, the saccharometer is used to measure the concentration of sugar solutions, alcoholometers are used to check the degrees proof, and salinometers to check the relative density of brine.

Temperature is measured in degrees Farenheit and degrees Celsius, the potential hydrogen (pH) is used to express the degree of acidity or alkalinity of a food.

Many terminologies are relevant and need to be known and their applications understood by the caterers.

KEY TERMS

Acrolein A substance formed when glycerol from fat is heated at high temperatures which is irritating to the eyes and the respiratory tract.

Additives All material added to food to improve its shelf life, colour, flavour, texture, taste, and quality such as flavouring agents, antioxidants, and preservatives.

Convenience foods Processed foods in which much pre-preparation/preparation has already been done by the manufacturer, e.g., frozen green peas, breakfast cereals, and canned foods.

Dry ice Solid carbon dioxide having temperature of –79°C and used to refrigerate foodstuffs being transported.

Food microbiology A study of bacteria, yeasts, and moulds, and their harmful and useful effects on food and its consumption.

Food science A study of the physical and chemical constituents of food and the scientific principles underlying their modification, preservation, and spoilage.

Food technology Application of the principles of food science to the preservation, processing, packaging, storage, and transportation of food materials.

Hygroscopic Readily absorbing water, such substances are used as drying agents, e.g., silica gel and calcium chloride.

Relative humidity Method of measuring the moisture present in air relative to saturation at the same temperature.

Rendering The process of removal of fat from the fat cells of adipose tissue of animals by dry heat method.

Silicone Organic compounds of silicon used on non-sticking wrapping paper.

REVIEW EXERCISES

1. What changes has the food industry witnessed in the last century?
2. Why is knowledge of the principles of food science necessary for a catering professional?
3. What do you understand by the term convenience foods? What foods does it include? Give suitable examples from your daily life.
4. Do you think convenience foods are necessary? Justify your answer giving suitable examples.
5. Define the following terms:
   (a) Viscosity
   (b) Osmosis
   (c) pH
   (d) Smoke point
   (e) Relative density
6. Give scientific reasons why:
   (a) Food takes longer time to get cooked at high altitudes
   (b) Fat used for deep fat frying should have a high smoke point

(c) The weight of a substance changes when weighed in different parts of the world
(d) Fresh eggs sink and stale eggs float in water
(e) Small amount of citric acid is added while making jelly preserve.

7. List the main factors which affect the rate of evaporation.
8. What does surface tension mean? Give two examples to explain this term.
9. How would you determine the density of a bread roll?
10. Convert the following measurements:
    (a) 2200 kcal into kJ
    (b) 37 °C into °F
    (c) 90 °F into °C
    (d) 5 ft 6 inches into cm
    (e) 8 ozs into ml