The chapter reviews those biochemical changes occurring in postharvest fruits and vegetables which affect quality. New developments in plant physiology have been incorporated including regulation of ethylene and genes encoding the enzymes involved in chlorophyll biosynthesis. The latest information on plant cell walls and textural changes during ripening is also included. A new section on flavor, including aroma and taste, has been added, as well as new developments in postharvest storage.

Polyphenol oxidase (PPO) is a group of copper proteins, widely distributed phylogenetically from bacteria to mammals, that catalyzes the oxidation of phenolics to quinones, which produce brown pigments in wounded tissues, playing a role in the defense mechanism against plant pathogens and herbivorous insects. The oxidation of phenolic substrates by PPO is important to some foods such as tea and cocoa. However, these reactions are thought to be the major cause of the brown coloration of many fruits and vegetables during ripening, handling, storage, and processing. This chapter discusses the current literature on the gene sequence, molecular mass, and kinetic properties of PPO obtained from different plants. Information about conventional and alternative methods to inactivate this enzyme is also presented.

This chapter describes the biochemical changes that transform milk into cheese and yogurt. Yogurt is milk coagulated by fermentation with thermophilic lactic acid bacteria. Historically presumed to be healthy, yogurt is currently used as a carrier for many nutritionally functional ingredients. The essential ingredients in cheese making are milk and a protein coagulant such as rennet and/or acid; the acid is normally produced by lactic acid bacteria. Rennet and acid alone or in combination cause milk proteins to transform fluid milk to a semi-firm gel. When this gel is cut into small pieces (curds), the whey (mostly water and lactose) separates from the curds. The
curds are then differentiated by various cheese-making procedures to produce the many different cheese varieties.

Biochemistry of Foods (Third Edition)  6  Browning Reactions in Foods  9780-122423529

Authors: N. A. Michael Eskin, Chi-Tang Ho, Fereidoon Shahidi

This chapter provides the latest information on browning reactions in foods, including mechanisms and methods of control. Since the second edition, the Maillard reaction or glycation has been shown to play an important role in aging and chronic diseases in humans. This chapter has incorporated the latest information on the structure and formation of melanoidins as well as the effect of polyphenols on these polymers. Also included is a discussion of the role that Strecker degradation plays in the conversion of asparagines to acrylamide. Besides the Maillard reaction, this chapter provides an in-depth review of both caramelization and ascorbic acid oxidation.

Biochemistry of Foods (Third Edition)  1  Cereals and Legumes  9780-122423529

Authors: Kequan Zhou, Margaret Slavin, Herman Lutterodt, Monica Whent, N.A. Michael Eskin, Liangli Yu

Cereal grains and legumes are complex biological structures with incredible importance as human dietary staples worldwide. Postharvest conditions and treatments, including storage, germination, and fermentation, are capable of causing significant biochemical changes that affect the nutritive value of these foods. In this chapter, mature grain and seed structure, as well as macronutrient synthesis, classifications, and storage forms within the seeds are discussed. The effects of storage conditions, and germination and fermentation processes are examined with regard to proximate and micronutrient composition, phytonutrient contents, the presence of anti-nutritional factors, and overall food quality.

Bioactive Foods in Promoting Health  3  Fruit and Vegetable Antioxidants in Health  9780-123746283

Authors: Manuela Blasa, Lorenzo Gennari, Donato Angelino, Paolino Ninfali

In the history of human nutrition, one of the most widespread alimentary regimens linked to health protection is represented by the Mediterranean diet (MD). MD eating patterns consist of
the wide use of whole grains, fruits, vegetables, nuts, fish, and olive oil. People obtain a wide range of antioxidants from the intake of a large variety of fresh fruits and vegetables. Investigations have shown that the risk of cancer and other chronic diseases is inversely related to the consumption of vegetables and fruits. Results are maximally oriented to attribute the highest protective role to the antioxidant compounds contained in fruits and vegetables. Processed fruits and vegetables show a wide range of phytochemical loss. The technology in the food industry should be used to reduce the loss of antioxidants and micronutrients to the minimum level by means of mild processes and the monitoring of each step of the transformation with due control assays. Functional foods, containing fruit and vegetable juices or extracts, are an important part of the healthy lifestyle, which includes a balanced diet and physical activity. To deliver their potential public health benefits, functional foods need to be quality controlled through the collaborative efforts of food-control organizations and the food industry, in order to market only those functional foods that are clearly supported with scientific evidence of nutritional value. The emerging field of nutrigenomics, or “personalized nutrition,” provides individual dietary recommendations and may one day have a greater ability to reduce the risk of disease.

Postharvest Handling (Second Edition) Nutritional Quality of Fruits and Vegetables 9780-123741127

Authors: Ariel R. Vicente, George A. Manganaris, Gabriel O. Sozzi, Carlos H. Crisosto

The nutritional value of fruits and vegetables depends on their composition, which shows a wide range of variation depending on the species, cultivar, and maturity stage. This chapter describes the general characteristics of the components of fruits and vegetables, related to their benefits as food sources. There are two types of acids, namely aliphatic (straight chain) and aromatic acids. The most abundant acids in fruits and vegetables are citric and malic (both aliphatic) acids. However, large amounts of tartaric acid occur in grapes. Malic acid is the major component in oranges and apples. The acid content of fruits and vegetables generally decreases during maturation. Aromatic organic acids occur in several fruits and vegetables, but in very low concentrations. Benzoic acid occurs in cranberries, quinic acid in bananas, and chlorogenic acid in potatoes. In general, vegetables are a richer source of minerals than fruits, but both vegetables and fruits are considered nutrient-dense foods in that they provide substantial amounts of micronutrients, such as minerals and vitamins, but relatively few calories. Minerals have both direct and indirect effects on human health. The direct effects of minerals focus on the consequences of their consumption on human nutrition, while the indirect effects refer to their incidence in fruit and vegetable quality and subsequent consumer acceptance. From a direct nutrition standpoint, potassium has the biggest presence in both
fruits and vegetables, but nitrogen and calcium show major impacts on horticultural crop quality.

Biochemistry of Foods (Third Edition) 3 Meat and Fish 9780-122423529
Authors: N.A. Michael Eskin, Michel Aliani, Fereidoon Shahidi

This chapter provides an in-depth review of the biochemical changes involved in the conversion of muscle into edible meat and fish. Major advances in our understanding of the nature and structure of muscle over the past two decades have been incorporated into this chapter. The latest information on the mechanisms of postmortem tenderization is included, focusing on the involvement of lysosomal cathepsin, calpains, and proteasomes. The chapter concludes with a comprehensive discussion of meat and fish pigments, including a detailed review of the structure of myoglobins and effective methods of preservation.

Wine Science (Third Edition) 4 Vineyard Practice 9780-123736468
Author: Ronald S. Jackson

In Chapter 3, details were given concerning the major physiological processes of grapevines. In this chapter vineyard practice, and how it impacts grape yield and quality, are the central focus. Because vineyard practice is so closely allied to the yearly cycle of the vine, a brief description of the growth cycle and its association with vineyard activities is given below.

Wine Science (Third Edition) 7 Fermentation 9780-123736468
Author: Ronald S. Jackson

The theory and practice of winemaking have changed fundamentally since its beginnings some 7500 years ago. Advancements, once sporadic, have come at an ever-quickening pace, reflecting developments in science and technology. Improvements in glass production and the use of cork favored the development of wine styles that benefitted from long aging. Sparkling wine also became possible. The research by Pasteur into problems of the wine industry during the 1860s led to solutions to several wine “diseases.” These studies also laid the foundation of our understanding of the nature of fermentation. Subsequent work has perfected winemaking skills to their present-day high standards. Further study should result in premium wines showing more consistently the quality characteristics that connoisseurs expect. In addition,
distinctive features based on varietal, regional, or stylistic differences should become more discernible and controllable. Dr Richard Peterson, a highly respected winemaker in California, has commented that Mother Nature is “a nasty old lady, who must be controlled.” Modern enologic and viticultural science is increasingly providing the means by which many of the vicissitudes of Mother Nature can be moderated, if not controlled.

Author: Graham G. Stewart

Although brewing is largely a biochemical/enzymatic process it also involves plant science, microbiology, chemistry, physics, engineering, process control, and flavor (taste) assessment. It is predominantly a batch process, although continuous systems have limited application. The process focuses upon four major raw materials: barley malt and other cereals, hops, water, and yeast. Current brewing procedures have two objectives. The first is efficiency with maximal use of fixed and variable overheads and the second is to produce stable, high-quality, drinkable beers. Process efficiency has been addressed by the introduction of high-gravity techniques, reduced maturation times, more efficient filtration systems and the advent of high-quality microbial enzymes (amylases, proteases, etc.), some developed with the use of genetic manipulation. In addition, beer stability (flavor, physical, and foam) has been enhanced by the use of a number of novel processing procedures.

Author: Ronald S. Jackson

Our understanding of the chemical nature of grapes and wine has advanced profoundly since the late 1960s. Although much remains to be discovered, the basic picture of what makes wine distinctive is beginning to emerge. Even the mysteries of the benefits of aging and barrel
maturation are yielding their secrets. This knowledge is beginning to guide vineyard and winery practice toward the production of more consistent and better-quality wine. Plant breeders are also using this information to streamline the development of new grape varieties.

Although remarkable progress has been made, there are limitations on its application. Some compounds cannot be detected by certain techniques, and some procedures produce chemical artifacts. These problems are minimized through the use of improved instrumentation and more than one analytical procedure. A more serious limitation lies in its sensory significance. Perception is separated by many neural steps from sensation in the mouth or nose (see Chapter 11). In addition, compounds may interact in complicated ways to influence sensory perception. Therefore, it is often difficult to predict how chemical composition will affect wine attributes. For example, only rarely can a particular varietal aroma or wine bouquet be ascribed to one or a few volatile compounds. Distinctive fragrances usually arise from the combined influences of many aromatic compounds, not a single varietally unique substance.

**Biochemistry of Foods (Third Edition)  11  Lipid Oxidation  9780-122423529**

Authors: Karen M. Schaich, Fereidoon Shahidi, Ying Zhong, N. A. Michael Eskin

Lipid oxidation is the major chemical reaction limiting the shelf-life of foods, and it also contributes to a wide range of pathologies, including aging and cancer. This chapter provides an interesting new perspective on broad aspects of lipid oxidation. It first reviews details of lipid oxidation reactions and mechanisms in the context of traditional free radical chain reactions and also in terms of multiple reaction pathways in which internal cyclization to epidioxides and epoxides, addition to double bonds, disproportionation, and scissions compete with hydrogen abstractions by lipid peroxyl and alkoxyl radicals. Subsequent sections cover chemical, physical, and environmental factors that influence the rates and course of lipid oxidation; consequences of lipid oxidation (production of off-flavors and odors, degradation of membranes and tissues, co-oxidation of proteins and other molecules by lipid radicals, hydroperoxides, epoxides, and carbonyl products), and inhibition of lipid oxidation by antioxidants and environmental control.

**Postharvest Handling (Second Edition)  1  Microbial Quality and Safety of Fresh Produce  9780-123741127**

Authors: Shlomo Sela, Elazar Fallik

Microbial quality of fresh produce refers to the overall effects of microbial activity, including growth, enzymatic activity, and metabolic byproducts upon the visual and organoleptic quality.
of fruits and vegetable. Microbial quality is microorganism-dependent, and is highly affected by chemical, physical, and biological factors pertaining to the cultivar and the environment. It is highly dependent on the conditions of cultivation, harvesting, handling, transport, and postharvest storage, as well as marketing conditions. Physical factors affecting growth and metabolic activity of microorganisms include temperature, pH, atmosphere, and moisture content. Chemical factors include the availability of nutrients and trace elements necessary for microbial growth, while biological factors include the presence of competing flora and interactions with the plant. There are various ways in which fruits and vegetables might become colonized by microbial flora, which could cause postharvest spoilage. Perhaps the most common route is the field’s colonization by soil saprophytes and plant parasites. However, microbial colonization could result from contaminated seeds, as well as via contact with other fruits and vegetables at any stage during harvest and postharvest, including handling, transportation, processing, and packaging. Microbial biota could spread not only by direct contact, but also through air and water. For example, washing produce in a water tank might share microorganisms within the entire lot.

Avian eggs have long been recognized as an excellent source of nutrients and food. The egg is a complete set of biological chemical substances with unique functional properties of egg proteins. The nutritional and functional properties of eggs have made it a very important ingredient in food systems. Understanding egg functional properties such as gelation, foaming, emulsifying, and coagulation, and the chemistry behind these properties, is important for the application of hen eggs in the food industry to develop novel products or improve the quality of existing products. This chapter provides a comprehensive account of the chemical composition of the egg and its functionality in order to improve the understanding of the changes that occur in eggs during food processing. Recent advances in egg protein processing technologies are also described.
Grapevines are classified in the genus *Vitis*, family Vitaceae. Other well-known members of the family are the Boston Ivy (*Parthenocissus tricuspidata*) and Virginia Creeper (*P. quinquefolia*). Members of the Vitaceae typically show a climbing habit, have leaves that develop alternately on shoots (Fig. 2.1), and possess swollen or jointed nodes. These may generate tendrils or flower clusters opposite the leaves. The flowers are minute, uni- or bisexual, and occur in large clusters. Most flower parts appear in groups of fours and fives, with the stamens developing opposite the petals. The ovary consists of two carpels, partially enclosed by a receptacle that develops into a two-compartment berry. The fruit contains up to four seeds.

This chapter covers the dynamic biochemical systems involved in the biosynthesis of milk components and includes a detailed examination of the chemistry and biochemistry of proteins, lipids, and lactose. Changes in the nomenclature of milk proteins over the past two decades are included, as well as the latest developments in our understanding of the milk fat globule membrane and casein micelle structure. In reviewing the biosynthesis of these components, new information on conjugated linoleic acid has also been added.
This chapter discusses the physical properties of food, properties that lend themselves to description and quantification by physical rather than chemical means. The physical properties of foods are of utmost interest to the food engineer, mainly for two reasons: many of the characteristics that define the quality (e.g., texture, structure, appearance) and stability (e.g., water activity) of a food product are linked to its physical properties and quantitative knowledge of many of the physical properties, such as thermal conductivity, density, viscosity, specific heat, enthalpy and many others, is essential for the rational design and operation of food processes and for the prediction of the response of foods to processing, distribution, and storage conditions. Some of the engineering properties will be treated in connection with the unit operations where such properties are particularly relevant (e.g., viscosity in fluid flow, particle size in size reduction, thermal properties in heat transfer, diffusivity in mass transfer etc.). Properties of more general significance and wider application are described in this discussion.

This chapter describes the dehydration, the removal of water by evaporation, from a solid or liquid food, with the purpose of obtaining a solid product sufficiently low in water content. The mechanism of water removal by drying involves two simultaneous processes, namely, transfer of heat for the evaporation of water to the food and transport of the water vapors formed away from the food. Drying is, therefore, an operation based on simultaneous heat and mass transfer. The rate limiting mechanism may be superficial evaporation or internal transport of water, depending on the conditions. The main technological objectives of food dehydration is transformation of a food to a form more convenient to store, package, transport and use, for example, transformation of liquids such as milk or coffee extract, to a dry powder that can be reconstituted to the original form by addition of water. Depending on the mode of transfer, industrial drying processes can be grouped in two categories: convective drying and conductive (boiling) drying. In former process hot and dry gas, usually air, is used both to supply the heat necessary for evaporation and
to remove the water vapor from the surface of the food, whereas, in latter process the moist food is brought into contact with a hot surface (or, in a particular application, with superheated steam) and the water in the food is boiled-off.

Fruit/Fruit Juice Waste Management: Treatment methods and potential use of treated waste 9780-123736543

Waste Management for the Food Industries 9

Biochemistry of Foods (Third Edition) 1
Recombinant DNA Technologies in Food 3 9780-12243529

Author: Peter Eck

Commercial transgenically produced products have become an essential part of our environment and food chain. This is demonstrated by the success of genetically modified crop varieties, which are starting to dominate the marketplace. Moreover, viable genetically modified microorganisms or isolates produced by them are utilized to produce food and food ingredients. This chapter identifies the major genetically modified organisms found in food to date, and summarizes their biochemistry and applications.

Beer 1
Beer Foam: Achieving a Suitable Head 9780-126692013

Soursop (Annona muricata L.): Composition, Nutritional Value, Medicinal Uses, and Toxicology 9780-123746283

Authors: Neela Badrie, Alexander G. Schauss

Soursop (A. muricata) fruit is useful as a processed product due to its high pulp recovery and many flavor compounds, particularly rich volatiles. Some constraints to processing are: short storage life of the soursop fruit; fragile peel; uneven ripening of soursop fruit, which makes the selection for processing tedious; loss of flavor by thermosensitive processing methods; and the
need to inactivate the enzymes in soursop pulp. Soursop is a good source of nutrition, yet \textit{A. muricata}, including its fruit, contains annonacin, the most abundant acetogenin, which has been experimentally demonstrated to be toxic in vitro and in vivo to dopaminergic and other neurons. Epidemiological evidence in several regions of the world has linked consumption of the fruit to an increased risk of developing atypical parkinsonism. The absence of family histories of parkinsonism and the cross-ethnic origins found among islands around the world led to the suggestion that consumption of soursop fruit and other consumables derived from this plant places those who consume the fruit at possible risk. Risk, associated with cross-interactions with compounds found in other foods, is suggested by the continued consumption of soursop in places like the North Marianna Islands and the virtual disappearance of atypical parkinsonism in recent decades. A clearer understanding of the risks associated with chronic intake of soursop is warranted given the presence of acetogenins and other alkaloids in the fruit so that competent and reliable dietary advice can be given.

\textbf{Bioactive Compounds in Mango (\textit{Mangifera indica})}

\textbf{Bioactive Foods in Promoting Health} 34 L.) 9780-123746283

Authors: Sônia Machado Rocha Ribeiro, Andreas Schieber

Mango is an important fruit for human nutrition in several parts of the world. It is a tropical fruit widely accepted by consumers throughout the world for its succulence, sweet taste, and exotic flavor, being called the “king of fruits.” It is a fruit with high nutritional value, supplying the human diet with calories, fiber, vitamins, and minerals. Flesh and agro-industrial residues of mangoes contain several bioactive compounds, comprising nutrient and non-nutrient substances with biological properties that act mainly via redox mechanisms. Compounds contained in mango flesh can act as biological antioxidants, maximizing the human antioxidant defense. Additive and synergistic effects of bioactive compounds from mangoes suggest that the fruit has great potential to improve health and reduce the risk of chronic diseases. Despite the numerous bioactive compounds in mangoes, which may promote benefits to human health, the potential for allergenicity of the fruit has been shown. Conventional technological processing of mango into flesh-containing products does not allow complete elimination of the allergenic potency. All mango varieties can supply the diet with nutrients, but considering that the contents of bioactive compounds are influenced by several factors, it was assumed that population groups with the same mango intake may be ingesting such compounds at different levels, not guaranteeing a comparable modulation potential of risk factors of diseases.
All wines undergo a period of adjustment (maturation) before bottling. Maturation involves the removal or precipitation of particulate and colloidal material. In addition, the wine experiences a range of physical, chemical, and biological changes that maintain or improve its sensory attributes. Many of these changes occur spontaneously, but can be facilitated by the winemaker. Although undue intervention can disrupt the wine's inherent characteristics, shunning any intervention can be equally detrimental. What is essential is that rational action, not philosophical (or marketing) dictates, take precedence.

The uniqueness of some aspects of plant structure is obvious, even to the casual observer. However, many fundamental features become apparent only when studied microscopically. Unlike animal cells, plant cells are enclosed in rigid cell walls. Nevertheless, each cell initially possesses direct cytoplasmic connections with adjacent cells, through thin channels called plasmodesmata. Thus, embryonic plant tissue resembles one huge cell, divided into multiple interconnected compartments, each possessing cytoplasm and a single nucleus. As the cells differentiate, many die and the plant begins to resemble longitudinal, semi-independent cones of tissue, connected primarily by specialized conductive (vascular) tissue.

This chapter deals with heat transfer and mass transfer principles that are based on essentially similar physical principles. In principle, they all obey a universal law, similar to the familiar Ohm's law, which can be expressed, in general terms as: the rate of transport (i.e., the quantity transported per unit time) is
proportional to the driving force and inversely proportional to the resistance of the medium to the transport. The basic principles of heat and mass transfer are described together while their applications are treated separately. All transport phenomena (fluid flow, heat and mass transfer, electric current etc.) are the result of lack of equilibrium between parts of the system. Heat transfer occurs via three fundamental mechanisms: conduction, convection, and radiation. Conduction refers to the transfer of heat through a stationary medium. Convection occurs when heat travels along with a moving fluid. Radiation is the transfer of heat in the form of electromagnetic radiation. Unlike the former two mechanisms, radiative heat transfer does not require the presence of a material medium between the two points. Further, heat exchangers are devices for the exchange of heat between two fluids separated by a heat conducting partition. Heat exchangers are extensively used in the food industry for heating (e.g., pasteurizers), cooling (chilled water generators), and heat induced phase change (freezing, evaporation). Each one of the two fluids may be confined or unconfined (free), stagnant or flowing. The partition is a heat conducting solid wall, usually made of metal. The design of a heat exchanger usually involves two main domains, namely thermal analysis and hydraulic calculations.

Freeze Drying
((lyophilization) and Freeze Concentration

Food Process Engineering and Technology 1e 23

Author: Zeki Berk

This chapter deals with freeze drying or lyophilization, the removal of water by sublimation from frozen state (ice). In this process, the food is first frozen and then subjected to high vacuum, whereby the water ice sublimates (i.e., evaporates directly, without melting). The water vapor released is usually caught on the surface of a condenser at very low temperature. In the food industry, interest in commercial freeze drying arises from the superior quality of the freeze-dried products as compared with foods dehydrated by other methods. Freeze drying is carried out at low temperature, thus preserving flavor, color and appearance, and minimizing thermal damage to heat sensitive nutrients. Since the entire process occurs in solid state, shrinkage and other kinds of structural changes are largely avoided. Freeze drying is, however, an expensive method of dehydration. It is economically feasible only in the case of high-value added products and whenever the superior quality of the product justifies the higher production cost.
This chapter discusses the preservation of food by refrigeration that based on a very general principle in physical chemistry: molecular mobility is depressed and consequently chemical reactions and biological processes are slowed down at low temperature. Food preservation at low temperature comprises two distinct processes: chilling and freezing. Chilling is the application of temperatures in the range of 0º C–8º C, that is, above the freezing point of the food, while freezing uses temperatures well below the freezing point, conventionally below −18ºC. The difference between the two processes goes beyond the difference in temperature. The stronger preserving action of freezing is due not only to the lower temperature but also and mainly to the depression of water activity as a result of conversion of part of the water to ice. The use of refrigeration in the food industry is not limited to preservation. Refrigeration is applied for a number of other purposes such as hardening (butter, fats), freeze concentration, freeze drying, air conditioning including air dehumidification, and cryomilling.

Edible oils are primarily derived from oil-bearing seeds and to a lesser extent from plants, mainly palm, olive, and coconut, or from animal sources. They are mainly composed of triacylglycerols and are generally extracted and then subjected to degumming, refining, bleaching, and deodorization. Some products are also winterized and hydrogenated. Other modification processes include interesterification and production of structured lipids or concentrates. Some products such as those of the omega-3 concentrates are known to promote health and reduce the risk of certain diseases.

Cow’s milk provides an important source of nutrients for humans, and the flavor of milk is a key parameter of product quality. Fresh milk has a pleasant aroma, flavor, mouth-feel, and
aftertaste. The flavor of milk is influenced by various genetic and environmental factors involved in milk production. The flavor composition of milk is complex; it contains at least 400 volatile compounds, including lactones, acids, esters, ketones, aldehydes, alcohols, furans, carbonyls, pyrazines, sulfur compounds, and aliphatic and aromatic hydrocarbons. The off-balance of these volatile compounds in milk can cause off-flavor, which is easily detected by the consumer. Off-flavors in milk can be categorized into heated, light-induced, lipolyzed, microbial, oxidized, transmitted, and miscellaneous. The most common off-flavor issues in the dairy industry, and possible methods to minimize or eliminate these off-flavors, are addressed in this chapter.

**Vegetable Waste Management:**
Treatment methods and potential use of treated waste

Waste Management for the Food Industries 11 waste 9780-123736543

**Food Process Engineering and Technology 1e**
Extrusion 9780-123736604

Author: Zeki Berk

This chapter describes extrusion, a process of central importance and widespread application in the food industry. The extensive development of extrusion technology represents one of the most significant achievements in food process engineering in the last 50 years. Extrusion cooking may be defined as a thermomechanical process in which heat transfer, mass transfer, pressure changes, and shear are combined to produce effects including cooking, sterilization, drying, melting. The extruder cooker is a pump, a heat exchanger, and a continuous high pressure–high temperature reactor, all combined in one piece of equipment. The first cooking extruders were single screw machines. They are still in use in some processes, but most recent installations are now twin screw extruders. Twin screw extruders comprise a pair of parallel screws, rotating inside a barrel with an 8-shaped cross-section. At the exit end, each half of the barrel converges into a short conical section, each with a die at the apex. The screws can be co-rotating or counter-rotating. The type most commonly used in the food industry is the co-rotating, self-wiping twin screw extruder. The production of pet foods is one of the highest volume applications of extrusion cooking. The processes utilized for the production of dry pet foods are essentially similar to those used for cereal products. Twin screw extrudates are used for the production of moist pet food.
In the food industry, raw materials and intermediate products must often be submitted to size reduction operations including cutting, chopping, grinding, and milling. This chapter discusses these size reduction operations. Size reduction is a widespread, multipurpose operation. Its may serve a number of different objectives such as: accelerating heat and mass transfer (flaking of soybeans or grinding coffee in preparation to extraction, atomization of milk as a fine spray into hot air in spray-drying); facilitating separation of different parts of a material (milling wheat to obtain flour and bran separately, filleting of fish); obtaining pieces and particles of defined shapes (cubing meat for stew, cutting pineapple to obtain the familiar wheel-shaped slices, cutting dough to make cookies). Compression and shear are the two types of force involved in size reduction of solids. Impact, sometimes given as a third type, is, in fact, strong compression applied for a very short time. When such forces act on a solid particle, elastic or plastic deformation occurs, depending on the material. As the deformation reaches a certain limit value determined by the nature and structure of the solid (mechanical strength), the particle breaks along certain planes (planes of failure). In any size reduction operation, all the types of force are usually involved, to different extent. In evaluating the performance of a size reduction operation, two aspects have to be considered: the PSD of the size-reduced material and the energy expenditure.

This chapter describes preservation of food material by the application of heat. Depending on the intensity, thermal preservation processes are classified into two categories: pasteurization and sterilization. In former process heat processing at relatively mild temperature (70–100°C), it destroys vegetative cells of microorganisms but has almost no effect on spores. In latter process, high temperature is subjected to the food material (above 100°C) with the objective of destroying all forms of
microorganisms, including spores. Sterilization alone provides long-term preservation of foods, on the condition that proper packaging prevents recontamination. Pasteurization, on the other hand, provides only short-term stability or requires additional preserving factors (hurdles) such as refrigeration or low pH for long-term effectiveness. In addition to pasteurization and sterilization, blanching may be considered a mild thermal treatment, the main purpose of which is to inactivate enzymes. It is mainly applied as a step in the preparation of vegetables prior to canning, freezing or dehydration. Immersing the vegetables in hot water or exposing them to open steam carries out blanching. Although its main objective is to inactivate certain enzymes, blanching has additional desirable effects such as enhancing the color, expelling air from the tissue and cleaning the surface.
This chapter discusses evaporation, the vaporization of a volatile solvent by ebullition to increase the concentration of essentially nonvolatile components of a solution or suspension. Evaporation is one of the most large-scale operations in the food industry. Plants with evaporation capacities of up to a hundred tons of water per hour are not uncommon. Made of special types of stainless steel, constructed according to high sanitary standards and equipped with sophisticated automatic control systems, evaporators for the food industry are relatively expensive. The most important running cost item in evaporation is energy. However, energy consumption per unit production can be reduced considerably through the use of multieffect evaporation or vapor recompression or both. In the food industry, the issue of thermal damage to product quality deserves particular attention. Evaporation under reduced pressure and correspondingly lower boiling temperature is widely practiced. However, lower temperature means higher viscosity of the boiling liquid, slower heat transfer and therefore longer retention of the product in the evaporator. Thus, the selection of evaporation type and of operating conditions is also subject to optimization with respect to product quality.
This chapter focuses on the thermal processes and methods in which the food is heated and cooled while contained in hermetically closed packages. The hermetic package protects the sterilized or pasteurized food from recontamination. The method is suitable for foods in all physical forms: solids, liquids or liquids with solid particles. The packages can be cans, jars, bottles, trays, tubes, pouches, etc. In the case of pumpable products (liquids, semiliquids, purees, suspensions of relatively small solid particles in liquids), it is possible to apply part or all the thermal treatment process continuously, in heat exchangers, before filling the product into containers. Additionally, bulk heating–hot filling–sealing–cooling in container is the standard method for canning high-acid pumpable products such as fruit juices and purees. The material is heated to pasteurization in continuous heat exchangers and then hot-filled and sealed. The filled containers are cooled by water, usually by spraying. In the case of metal cans, cooling may be accelerated by spinning the container around its axis. The main disadvantage of the method is the relatively long cooling time, resulting in over-cooking of the product and requiring long cooling lines.
sensory quality of many liquid and semiliquid foods depends, to a large extent, on the flow properties of the product. The study of fluids in motion is referred as fluid dynamics. There are two critical elements of fluid dynamics viscosity and fluid flow regimes. The viscosity of liquids is strongly temperature-dependent and almost pressure independent. The viscosity of gases increases with pressure and decreases slightly with increase in temperature. There are two types or regimes of fluid flow. The first is called laminar or streamlined flow. The other is turbulent flow. The type of flow depends on the mass flow rate, the density and viscosity of the fluid, and the geometry of the flow channel. These variables are combined in a dimensionless group known as the Reynolds number (Re). Further, with respect to flow properties, fluids are classified according to the relationship between shear stress $\tau$ and shear rate $\gamma$: Newtonian fluids, Bingham fluid, Shear thinning or pseudoplastic fluids, Shear thickening or dilatant fluid, and Herschel–Bulkley fluids. Additionally, technical elements such as pumps and piping, used for conveying fluids are also discussed.

**The Science of Grapevines**

**Environmental Constraints and Stress Physiology**

**Bioactive Foods in Promoting Health**

**Pomegranate in Human Health: An Overview**

Authors: Ana Faria, Conceição Calhau

This chapter provides an update of current knowledge on basic principles and concepts, as well as clinical nutrition evidence of pomegranate effects on the prevention and treatment of disease. Pomegranate (*Punica granatum* L.), an ancient and mystical fruit, is the predominant member of two species comprising the Punicaceae family. Modern uses of pomegranate include treatment of acquired immune deficiency syndrome, hormone replacement therapy, cardiovascular protection, oral hygiene, adjunct therapy to increase bioavailability of radioactive dyes during diagnostic imaging, as well as cosmetic beautification and enhancement. Among the great variety of chemical components present in the pomegranate, ellagic acid, ellagitannins, punic acid, anthocyanins, flavonols, flavan-3-ols, and flavones seem to be responsible for most of the therapeutic benefits from the consumption of pomegranate. Pomegranate juice is the greatest contributor to pomegranate ingestion. The main antioxidant compounds in pomegranate juice are hydrolyzable tannins, with the contribution of anthocyanins and ellagic acid derivatives. There are some differences in phenolic composition between commercial juices and experimental ones. The use of the arils alone or the whole fruit to make juice has an enormous impact on polyphenol content and consequently on antioxidant
capacity of the juice. Practitioners of the Ayurvedic and Unani systems of medicine have used pomegranate for centuries as a therapeutic agent for the treatment of inflammatory diseases and disorders of the digestive tract.

### The whey proteins in milk:
- **Thermal denaturation**
- **Physical interactions**
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### Wine Science (Third Edition)
- **9** Specific and Distinctive Wine Styles | 9780-123736468

Author: Ronald S. Jackson

Wine has been produced for millennia, but many modern styles have no ancient equivalent. Wine styles often reflect the unique climatic and politico-economic environment in which they arose. For example, botrytized wines emerged in regions favoring the selective development of noble-rot, sparkling wine evolved in a region (Champagne) unsuitable for standard red wine production, and port arose out of expanded trade between England and Portugal, due to conflicts and trade restrictions with France. Some of these wine styles have spread throughout the world. Others have remained local anomalies. This chapter covers some of the more important and unique wine styles.

### Food Process Engineering and Technology
- **1e** Frying, Baking, Roasting | 9780-123736604

Author: Zeki Berk
This chapter discusses the frying, baking, and roasting, a thermal process of food preparation. Roasting and baking are cooking in hot air. Although the same basic principles govern both operations, the term baking is usually reserved for dough products, while the term roasting refers to the application of dry heat to all other types of foods, from meats to snacks. Frying, on the other hand, is cooking in fat. As a unit operation, it is quite distinct in the mechanisms involved, its kinetics, its nutritional and safety aspects and the operation principles of the equipment used for its implementation. The primary objective of baking, roasting, and frying is the transformation of foods into products with improved eating quality. At the same time, these processes contribute to the short-term stability of foods by means of two mechanisms: heating and drying. Long-term preservation is usually not expected from these operations, unless they are combined with other preservation methods.

This chapter presents various refrigeration methods available. Two types of sources deliver a low temperature: mechanical refrigeration, cryogenic agents. The basic principle of the most common type of mechanical refrigeration is a cyclic thermodynamic process known as the Rankine cycle or a vapor compression cycle. The fluid undergoing the cycle is called a refrigerant. Although, theoretically, the reverse Rankine cycle could be run with any fluid, only certain compounds and mixtures are suitable for use in practical refrigeration. Additionally, cold storage is distinguished from ambient storage by the presence of two features: thermal insulation and a source of cold. Thermal insulation is provided by an appropriate thickness of porous material with a cellular (polymer foam) or fibrous (mineral wool) structure. Moisture reduces drastically the efficiency of thermal insulation. It is therefore necessary to provide a moisture barrier, in the form of a plastic film or aluminum foil applied on the outer (warmer) face of the insulation.

Wine has an archeological record dating back more than 7.5 thousand years. The earliest suspected wine residues come from the early to mid-fifth millennium B.C. – Hajji Firuz Tepe, in the northern Zagros Mountains of Iran (McGovern et al., 1996). Evidence from Neolithic pottery from Georgia suggests that contemporaneous wine production was dispersed throughout the
region (McGovern, in preparation). Older examples of fermented beverages have been discovered (McGovern et al., 2004), but they appear to have been produced from rice, honey, and fruit (hawthorn and/or grape). Such beverages were being produced in China as early as 7000 B.C. The presence of wine residues is usually identified by the presence of tartaric acid residues, although additional procedures for identifying grape tannin residues are in development (Garnier et al., 2003).

Other than the technical problems associated with identifying wine residues, there is the thorny issue of what constitutes wine – does spontaneously fermented grape juice qualify as wine, or should the term be restricted to juice fermented and stored in a manner to retain its wine-like properties?

Author: Ronald S. Jackson

Color

The visual characteristics of a wine depend on how its chemical and particulate nature transmit, absorb, and reflect visible radiation. Although some of these characteristics can be accurately measured with a spectrophotometer (Fig. 8.18), the relevance of the data to human color perception is far from direct. Spectrophotometric measurements assess the intensity of individual wavelengths, whereas the eye responds to the reflective and transmissive properties of light and its relative brightness. This involves a combination of reactions from two types of receptor neurons (cones and rods), as well as several other receptors. The cones adjust quickly to changing light intensities and quality. They generate color and high resolution vision. Cones
exist in three forms, L, M, and S. They respond differentially, but over a broad range, to portions of the visible spectrum. They respectively have peak sensitivities in the yellow, green, and violet. In contrast, the rods adjust more slowly to adjusting light levels, are receptive to low intensity light of medium and short wavelengths, are primarily responsible for motion detection, and generate night vision. The perception of color is complicated as it involves interpretation not only of impulses from the cones, but also information from other receptors concerning light intensity and contrast between colored regions. Consequently, there is no simple relationship between spectrophotometric measurements and human color perception (see Kaiser, 1996).

Food Process Engineering and Technology 1e    7    Mixing    9780-123736604

Author: Zeki Berk

This chapter focuses on the fundamental of mixing whose objective is to increase the homogeneity of material in bulk. In process technology, however, mixing or agitation may be used to achieve additional effects such as enhancing heat and mass transfer, accelerating reactions, changing the texture, etc. Very often, mixing occurs simultaneously with size reduction, as is the case in foaming, homogenizing, and emulsification. The basic mechanism in mixing consists in moving parts of the material in relation to each other. It is useful to discuss separately the mixing (blending) of liquids and the mixing of solids. In liquid–liquid and liquid–gas mixing, the collision between the moving domains results in interchange of momentum or kinetic energy. The scientific discipline most relevant to liquid mixing is therefore fluid mechanics. The energy input per unit volume is closely related to the quality of mixing. In contrast, the mixing of particulate solids such as powders is governed by the laws of solid physics and statistics.

Food Process Engineering and Cleaning, Disinfections, Sanitation 9780- 27 123736604

Author: Zeki Berk

This chapter focuses on the hygiene aspect of food processing. Hygiene considerations affect all the phases of food processing, including decisions in plant and process design, equipment selection, specification and handling of raw materials and packaging, maintenance of the physical plant and its environment, selection and training of the personnel at all levels, the overall conduct of activities and the culture in a food processing plant. One of the problems in the application of engineering methodology to hygiene is the difficulty in expressing dirt and cleanliness in objective, exact and quantitative terms.
Despite considerable progress in establishing quantitative standards and a rational approach to hygiene, subjective attitudes based on personal and collective customs, culture and esthetics still have an important part in the daily practice. Until recently, food plants utilized enormous quantities of water for cleaning. Most of the used water was not recycled but discharged as waste. Another resource that was also used indiscriminately and in exaggerated quantity was energy. Today, the laws and economics compel the food industry to develop more rational technologies of cleaning, less wasteful in water and energy and more environment-friendly.

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