

# Dairy Science

## 21. DAIRY CHEMISTRY

### Unit 1

Milk constituents, their normal contents and physical and chemical nature. Specific compositional differences among milk from various species; Variations in milk composition due to breed, feed, season, stage of lactation and mastitis; Colostrum and abnormal milks, physical properties of milk; Acid base equilibria, oxidation-reduction potential, density, viscosity, interfacial tension, freezing point, electrical conductivity, thermal conductivity, refractive index, milk buffer capacity, physical equilibria among milk salts; Effect of various treatments on salt equilibria; Salt balance and its importance in processing of milk; Water activity, and its effect on shelf life; Colloids, properties and colloidal stability of milk; Emulsions, foams and gels formation, their stability and importance in dairy processing.

Lactose – structure, isomers, physical, chemical and biochemical properties. Browning mechanisms. Estimation and biosynthesis. Lactose intolerance. Significance of carbohydrates in milk and milk products. Distribution of trace elements in milk and their technological and nutritional importance; Water soluble vitamins – molecular structure and their levels in milk and milk products, biological significance, and factors affecting their levels.

### Unit 2

Levels, distribution, isolation and genetic polymorphism of different milk proteins; Casein micelles – structure, size distribution, stability and physico-chemical properties; Casein models. Amino acid composition and physico-chemical properties of different fractions of caseins; Whey process, denaturation of milk proteins as influenced by temperature, pH and additives; Biosynthesis, structure, function and physico-chemical properties of  $\alpha$ -lactalbumin and  $\beta$ -lactoglobulin, immunoglobulins, lysozyme, lactoferrins, lipoproteins and fat-globule membrane proteins and their importance; Milk protein allergenicity; Role in immune response; Chemistry of milk enzymes and their significance with reference to milk processing and milk products. Kinetics of chemical reactions and enzyme kinetics; Casein hydrolysate, co-precipitates, and whey protein concentrates; bioactive peptides.

### Unit 3

Milk lipids – classification, composition, structure and general physical and chemical properties. Auto-oxidation – definition, theories, factors affecting, prevention and measurement. Antioxidants – mechanism of reaction and estimation. Lipolysis. Fatty acids – profile, properties and affecting factors. Unsaponifiable matter. Cholesterol – structure, forms, importance and level in milk. Chemistry of phospholipids and their role in milk and milk products. Fat – soluble vitamins – chemistry, physiological functions, levels in milk, cream, butter and ghee. Biosynthesis of milk fat. CLA biosynthesis and its nutritional and health benefits.

### Unit 4

Milk adulteration and detection methods; Estimation methods for antibiotics, pesticides, heavy metals, lactose, lactate, protein, total solid, fat, salt, vitamin C, calcium, phosphorous, iron, citric acid in milk and milk products. Estimation of vitamin A, total phospholipids and free fatty acids in ghee. Estimation of starch in food. Measurement of BOD and COD in dairy waste.

### Unit 5

Cream – Size distribution of fat globules, creaming phenomenon, composition and properties of cream and dry cream. Chemistry of neutralization and ripening. Butter. Mechanism of churning during butter preparation. Desi and creamery butter composition, properties, microstructure, grading, standards and defects. Ghee –

Compositional differences in ghee prepared by different methods and variations in ghee and butter oil, Analytical constants and factors affecting them. Differences in cow and buffalo ghee. Hydrolytic and oxidative deterioration of ghee, their causes and prevention. Adulteration of ghee and methods of detection. Ghee grading, Antioxidants: natural and synthetic. Physico-chemical characteristics of buttermilk and ghee residue.

#### **Unit 6**

Heat stability of milk as affected by various milk constituents and additives. Role of protein-protein interaction and age gelation of UHT milk. Physical and chemical changes during preparation of concentrated milk and subsequent storage. Compositional differences between condensed and evaporated milk. Dried milk; Structure and physico-chemical properties. Physical properties of instant powder, Infant food. Spoilage of milk powder and its control. Khoa : composition and changes during manufacture. Composition and changes during preparation of chhana and paneer.

#### **Unit 7**

Cheese : Composition and varietal differences. Chemistry of rennin action. Influence of acidity, renneting and heat on the process of cheese manufacture. Changes during manufacture and ripening. Role and mechanism of action of stabilizers and emulsifiers, rheological properties and defects of cheese. Milk clotting enzymes from different sources – microbial, animal and plant. Theories and metabolic pathways of fermentation. Dahi, yoghurt and Acidophilus Milk : Composition and specific differences, chemical changes during fermentation, flavour development. Composition of Lassi and buttermilk. Nutritional and therapeutic significance of fermented milk products.

#### **Unit 8**

Ice-cream : Composition and physical structure; changes during ageing, freezing, hardening and defects. Role and mechanism of stabilizers and emulsifiers. Kulfi: composition and differences with ice-cream.

#### **Unit 9**

Definition of quality, quality control and assurance. Standards, statutory and voluntary organization. PFA act, sampling, labelling, PFA and AGMARK, BIS, ISO9000 standards for milk products. Total quality management, sensory evaluation of milk and milk products. Calibration of glasswares (lactometer, butyrometer, milk pipette, thermometer) used in Quality control laboratory, legal requirements of packaging material and product information, nutrition labelling.

#### **Unit 10**

Spectroscopy – UV – Vis spectrophotometry, IR. Separation techniques : TLC, GLC, HPLC, Ion exchange, size exclusion, affinity chromatography, analytical sedimentation, sedimentation equilibrium, isopycnic ultracentrifugation. Ultrafiltration. Precipitation by salting out agents. Electrophoresis – PAGE, SDS-PAGE, Radio-tracers technique. Flame photometry and potentiometry (principle, various electrodes, electrometric measurements of pH, buffers).

## **23. DAIRY TECHNOLOGY**

### **Unit 1 : Market Milk**

Status of dairy industry in India. Recent policy changes related to dairy sector (MMPO & WTO). Principles and practices for production of high quality milk. Methods of milk procurement, payment, quality assessment, detection of adulterants, handling and transportation of milk. Methods of raw milk preservation. Physical properties and chemical composition of milk of cow, buffalo and other species of milch animals; their importance in milk processing. Centrifugal separation, clarification and bactofugation and factors affecting their efficiency. Homogenization process and its implications in dairy processing; efficiency of homogenization and factors affecting it. Thermal processing of milk. Principles and methods of pasteurization and sterilization. UHT processing and aseptic packaging. Special milks. Principles of production, processing and marketing of toned, double toned, reconstituted, recombined, flavoured and filled milks.

### **Unit 2 : Fat Rich Dairy Products**

Basic principles and recent concepts in production and processing of different types of cream, butter, margarine, fat spreads, butter oil and *ghee*. Fractionation of fat and its application. Health aspects of milk fat. Cholesterol reduced and cholesterol-free dairy products.

### **Unit 3 : Frozen Milk Products**

Trends in the frozen milk products industry in India. Definition, classification and composition of ice-cream and other frozen desserts. Role of milk constituents and other ingredients, processing steps, packaging and storage methods on quality of ice-cream. Technological aspects of manufacture of plain, fruit, soft-serve, low fat and dietic ice-creams and novelties. Indigenous frozen desserts, kulfi, malai-ka-baraf etc.; their production techniques and quality. Distribution of frozen desserts. Newer ingredients for use in the ice-cream industry.

### **Unit 4 : Cheese and Fermented Milk Products**

Status and scope of cheese industry. Fermented milk products – their nutritional and therapeutic value. Definition and classification of cheese and fermented milks. Milk in relation to cheese making. Manufacture of Cheddar, Gouda, Mozzarella and Swiss cheeses. Role of starter cultures in cheese quality. Types of rennet for cheese manufacture. Physical and chemical changes during cheese ripening. Manufacture of processed cheese, cheese spread and cheese foods. Mechanization of cheese-making process. Modern concepts in accelerated cheese ripening. Storage and defects. Production and storage of *dahi*, yoghurt, *shrikhand*, *lassi* and *misti dohi*. Probiotic dairy products.

### **Unit 5 : Concentrated and Dried Milk Products**

Milk in relation to processing and manufacture of concentrated and dry milks. Principles and methods of manufacture, storage and defects in sweetened condensed milk. Evaporated milk. UHT sterilized concentrated milk. Whole milk powder. Skim milk powder, high-fat powders, and ice-cream powder. Instantization of milk powder. Newer technologies and formulations for infant foods and weaning foods, malted milk and malted milk foods.

**Unit 6 : Indigenous Milk Products**

Status and role of traditional dairy products in Indian dairy industry and economy. Characteristics of various traditional products, their prospects and constraints. Methods of production; physico-chemical changes during manufacture; quality attributes, shelf-life, preservation and packaging. Process innovations relating to *khoa*, *chhana*, *paneer*, *rabri*, *kheer*, *khoa* and *chhana*-based sweets.

**Unit 7 : Utilization of Milk Byproducts**

Status, availability and utilization of dairy byproducts. Associated economic and pollution problems. Manufacture of casein, sodium and calcium-caseinates, edible casein, hydrolysates, coprecipitates, whey protein concentrates, whey beverages, whey syrups and lactose. Use of buttermilk. Development / formulation of new products based on dairy byproducts.

**Unit 8 : Packaging of Milk and Milk Products**

Present status and scope. Role of packaging and package design considerations. Evaluation of packaging materials and package performance. Packaging materials and systems for liquid, concentrated, dried, frozen and fat-rich dairy products. Special packaging methods such as vacuum, shrink and aseptic packaging. Modified atmosphere packaging. Package standards, regulations and quality control.

**Unit 9 : Cleaning and Sanitation**

Properties of important dairy detergents and sanitizers. Choice of detergents and sanitizers guiding principles and limiting factors. Basic principles in formulating the cleaning and sanitizing procedures for dairy equipments. Automation in cleaning and sanitization processes including CIP. Quality of water in detergency.

**Unit 10 : Advances in Dairy Technology**

Radiation preservation of milk and milk products. Theory and application of microwave heating, ohmic heating and high pressure processing. Immobilization of enzymes and their use in dairy and food industry. Theory of ultrafiltration, reverse osmosis, nanofiltration and microfiltration techniques. Selection and types of membranes. Application of membrane technology in dairy and food industry. Fouling, cleaning and sanitization of membranes. Emulsions, foams and gels. Electrodialysis and ion exchange in dairy applications. Processing of cereals and legumes for incorporation in milk and milk products. Use of milk solids in bakery and confectionery products. Application of biotechnology in dairy industry.

**Unit 11 : Legal and Quality Aspects for Milk and Milk Products**

Safety aspects of milk with reference to mycotoxins, antibiotics, pesticides, weedicides and heavy metals. PFA, BIS and Agmark standards for milk and milk products. Quality systems such as HACCP, ISO certification, etc.