34 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; Properties of Colloids 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 proteins, denaturation of milk proteins as influenced by temperature, pH and additives; Biosynthesis, structure, function and physico-chemical properties of α-lactalbumin and β-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. Functional properties of milk proteins and their modifications using enzymatic and physical treatments.

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 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.Role of international organisations such as ISO, IDF, CAC, AOAC, WTO and national organisations like BIS, FSSAI, AgMark and APEDA in dairy industry, Quality Council of India (QCI), Export Inspection Council (EIC); guidelines for setting up quality control laboratory and chemical safety aspects; sampling of milk and milk product; food labeling

guidelines. FSSAI, AGMARK and BIS standard for milk and milk products Agro-chemicals/veterinary drug residues; occurrence of pesticide residues, antibiotic residues, heavy metals etc in dairy products, Laboratory auditing, Food traceability systems, Food recall and withdrawal.

Unit 10

Spectroscopy – UV – Vis spectrophotometry, IR. Separation techniques : TLC, GLC, HPLC, Ion exchange, size exclusion, affinity chromatography, ultracentrifugation. Ultrafiltration. Precipitation by salting out agents. Electrophoresis – PAGE, SDS-PAGE, Immuno based analytical techniques such as ELISA & Lateral flow assay. Flame photometry, AAS and potentiometry (principle, various electrodes, electrometric measurements of pH, buffers)

35.a. FOOD PROCESSING TECHNOLOGY

Unit 1: Introductory Food Technology

Introduction to food technology, Food processing industries/institutions/food scientists of importance in India, Food attributes *viz*. colour, texture, flavour, nutritive value and consumer preferences, Causes of food spoilage, sources of microbial contamination of foods, food borne illnesses, water activity and its relation to spoilage of foods, Spoilage of processed products and their detection, Principles and methods of food preservation. Food fortification, Composition and related quality factors for processing. Methods of food preservation such as heat processing, pasteurization, canning, dehydration, freezing, freeze drying, fermentation, microwave, irradiation and chemical additives. Refrigerated and modified atmosphere storage. Aseptic preservation, hurdle technology, hydrostatic pressure technology and microwave processing. Use of non-thermal technologies (microfiltration, bacteriofugation, ultra high voltage electric fields, pulse electric fields, high pressure processing, irradiation, thermosonication), alternate-thermal technologies (ohmic heating, dielectric heating, infrared and induction heating) and biological technologies (antibacterial enzymes, bacteriocins, proteins and peptides) in food processing. Role of Food additives and processing aids.

Unit 2: Technology of Foods of Plant Origin

Fruits and Vegetable Processing: Post harvest handling and storage of fresh fruitsand vegetables. Preparation of fruits and vegetables for processing.Minimally processed products.Cold chain logistics. ZECC (Zero Energy Cool Chambers), CCSR (Charcoal cool storage Rooms). Thermal processing and process time evaluation for canned products, process optimization, aseptic canning, methods for canning of different fruits, and vegetables; Dehydration and associated quality changes during drying and storage of dehydrated products. Solar drying. Intermediate moisture foods. Preparation and utilization of fruits and vegetables juices in non-fermented/fermented/ aerated beverages, health drinks. Role of membrane technology in juice processing.Chemistry and manufacture of pectin, role of pectin in gel formation and products like jellies, jams and marmalades.
Technology of Preserves, Pickles, Chutneys and Sauces. Nature and control of spoilage in these products, Re-structured fruits and vegetables, Byproducts utilization infruits and vegetable processing industry, Processing methods of frozen fruits and vegetables, IQF products, packaging, storage and thawing, Role of Pectinases. Tomato products such as juice, puree, paste, soup, sauce and ketchup, Other convenience foods from fruits and vegetables. Beverages, tea, cocoa and coffee processing. Spent coffee ground. Medicinal and aromatic plants: their therapeutic values. Spice processing viz. cleaning, grading, drying, grinding, packaging and storage. Oleoresins and essential oils.

Food grain Processing: Structure, composition of different grains like wheat, rice,barley, oat, maize and millets, Anti-nutritional factors in food grains and oilseeds, Milling of grains. Wheat flour/semolina and its use in traditional/non-traditional foods like breads, biscuits, cakes,

doughnuts, buns, pasta goods, extruded, confectionary products, breakfast and snack foods. Rheology of wheat and rice flour, Preparation of vital wheat gluten and its utilization, Instant ready mixtures, Enzymes (amylases and proteases) in milling and baking, Milling and parboiling of rice; by-products of rice milling and their utilization, Processed products from rice, Pearling, malting, brewing and preparation of malted milk feeds from barley, Significance of β-glucans, Milling of oats and its processing into flakes, porridge and oatmeal, Wet and dry milling of corn, manufacture of corn flakes, corn syrup, corn starch, corn steep liquor and germ oil, Structure and composition of pulses and their importance in Indian diet. Milling and processing of pulses viz. germination, cooking, roasting, frying, canning and fermentation. Use in traditional products, protein concentrates and isolates. Modified starches and proteins. Oilseeds: edible oilseeds, composition and importance in India. Oilseed processing.Oil extraction and its processing, byproducts of oil refining. Production, packaging and storage of hydrogenated vegetable fat (Vanaspati), peanut butter, protein concentrates, isolates and their use in high protein foods. Soybean protein concentrates and isolates.Soy lecithin extraction.Export of oilseed cakes. International market and consumer preferences for quality in cakes for use in textured vegetable proteins. Millets: composition, nutritional significance, structure and processing. Dairy analogues based on plant milk.

Unit 3: Technology of Foods of Animal Origin

Technology of Milk and Milk Products: Milk and Milk production in India.Importance of milk processing plants in the country.Handling and maintenance of dairy plant equipment.Dairy plant operations viz. receiving, separation, clarification, pasteurization, standardization, homogenization, sterilization, storage, transport and distribution of milk. Problems of milk supply in India. UHT, toned, humanized, fortified, reconstituted, recombined and flavoured milks.Technology of fermented milks. Milk products processing viz. cream, butter, *ghee*, Cheddar and mozzarella cheeses, condensed milk, evaporated milk, whole and skimmed milk powder, malted food, ice-cream, butter oil, *khoa*, *channa*, *paneer*and similar products. Concept of composite dairy foods.Judging and grading of milk products. Cheese and dairy-based fat spreads. EMC (Enzyme modified cheese), Enzymes in dairy processing. Sanitization *viz*. selection and use of dairy cleaner and sanitizer.In plant cleaning system. Scope and functioning of milk supply schemes and various national and international organizations. FSSAI specifications and standardsof milk and milk products.Dairy plant sanitation and waste disposal.

Technology of Meat / Fish / Poultry Products: Scope of meat, fish and poultryprocessing industry in India, Chemistry and microscopic structure of meat tissue, Ante mortem inspection, Slaughter and dressing of various animals and poultry birds, Post mortem examination, Rigor mortis, Retails and wholesale cuts, Factors affecting meat quality. Curing, smoking, freezing, canning and dehydration of meat, poultry and their products.Sausage making. Microbial factors influencing keeping quality of meat. Processing and preservation of fish and its products.Handling, canning, smoking and freezing of fresh water fish and its products.Meat tenderization and role of enzymes in meat processing.Utilization of by-products.Zoonotic diseases.Structure and composition of egg and factors affecting quality.Quality

measurement.Preservation of eggs using oil coating, refrigeration, thermo stabilization and antibiotics.Packing, storage and transportation of eggs.Technology of egg products viz. egg powder, albumen, flakes and calcium tablets. Industrial and food uses.Physiologicalconditions and quality of fish products.

Unit 4: Food Quality Management

Objectives, importance and functions of quality control. Quality systems and tools used for quality assurance including control charts, acceptance and auditing inspections, critical control points, reliability, safety, recall and liability. The principles and practices of food plant sanitation. Food and hygiene regulations.Environment and waste management. Total quality management, good management practices, HACCP and codex in food. International and National food laws including food recall regulations. US-FDA, EFSA, ISO-9000 and FSSAI.Food adulteration.Sensory evaluation, panel screening, selection methods.Sensory and instrumental analysis quality control.Quality control of food at all stages and ofpackaging materials.Non-destructive food quality evaluation methods.Biosensors and their use in quality evaluation of food products.Aspects of food safety.

Unit 5: Food Engineering/Packaging and Labeling

Unit operations of food processing viz. grading, sorting, peeling and size reduction machineries for various unit operations, energy balance in food processing.Functions and levels of food packaging.Packaging materials: properties and testing procedures.Metal cans: types, mechanism of corrosion and protective coatings. Packaging requirements and practicesof fresh and processed foods. Shelf life studies. Recent trends in packaging, aseptic, modified atmosphere, vacuum and gas packaging, active and intelligent/smart packaging, antimicrobial packaging, edible films and coatings, biodegradable and nanocomposite materials for food packaging. Food packagingand labeling requirements as per FSSAI regulations.Principles of package design.

Unit 6: Food Microbiology & Biotechnology

Fermentation technology, fermented food products (animal and plant based including cereal), microbial spoilage of foods, bacterial growth curve, hurdle technology.Role of biotechnology in productivity of plants, livestock and microbes of improved nutrition and quality. Use of biotechnology in production of food additives viz. preservatives, colorants, flavours. Use of biotechnologically improved enzymes in food processing industry, biomass production using industrial wastes.Single cell proteins, Single cell oils, Food contaminants viz. aflatoxins.Food intoxication and infection. Consumer concerns about risks and values, Biotechnology and food safety.

Unit 7: Flavour Chemistry Technology

Flavour composition of foods/beverages (identification and quantitative analysis of the flavour precursors and their products, characterization of the staling reaction using stable isotopes).Flavour composition of foods/beverages in relation with maturation and microbial activity/or the processing conditions (e.g. fermented dairy products, beer, wine, honey, fruits). Analysis of odour-active compounds of food/beverages (Charm analysis).Synthesis of flavour by microorganisms and plant cells. Lipid derived flavours. Investigation of equilibrium of key flavour compounds that govern the flavour stability of beverages.Natural antioxidant constraints in spices.Role of microorganisms in flavour development.Flavor emulsions, flavour composites, essential oils and oleoresins.

Unit 8: Consumer Sciences/Food Product Development/Health Foods

Socio-cultural, psychological and economical consideration for food appearance, domestic and export marketing.Consumer trends and their impact on new product development.Product development viz. to conceive ideas, evaluation of ideas, developing ideas into products, test marketing and commercialization.Role of food in human nutrition. Nutritional disorders, natural contaminants and health hazards associated with foods. Diet therapy.Therapeutic / Engineered / Fabricated and Organic foods/ Nutraceutical and functional foods.FSSAIregulations related to food fortification,nutraceuticals and organic food.