

Tamil Nadu Public Service Commission

Syllabus

**Dairy Chemistry, Dairy Science, Chemistry, Bio-Chemistry, Microbiology
and Bio-Technology**

(PG Degree Standard)

Code:580

**Unit I: Chemistry of Milk Lipids, Proteins, Carbohydrates, Vitamins and Minerals
(20 Questions)**

Definition of Milk as per FSSAI. Average Composition of milk from cow, buffalo and other species. Factors affecting the composition of milk. Casein Micelles, Globular Proteins, Lipoprotein Particles. Kinetics of denaturation of whey proteins. Kinetics of enzymatic reactions. Electrolytic dissociation. Redox reactions and photo-oxidation of milk. Adsorption at solid-vapour interphase. Hysteresis. Sorption of water on milk constituents and its relation to stability of dairy products. Foams and emulsions. Micelles and gelation.

Classification of milk lipids. Composition of milk fat globule membrane. Fatty acid profile of cow and buffalo milk fats. Factors affecting the profile of fatty acids. Properties of fatty acids. Saponifiable and unsaponifiable matter and its importance. Chemical properties of milk lipids – hydrolysis, hydrogenation, halogenation, transesterification, fractionation. Oxidation of milk fat – auto-oxidation, antioxidants and thermal oxidation of fat.

Nomenclature of milk proteins. Genetic polymorphism. Biological significance of the milk proteins - Casein, its methods of isolation, fractionation and heterogeneity. Amino acid composition. Primary structure of different caseins. Modification of casein. Minor milk proteins - Whey proteins - distribution and methods of isolation and their physico-chemical properties. Other Minor milk proteins - Proteose-peptone, immunoglobulins, lactoferrin, and fat globule membrane proteins. Denaturation of milk proteins. Various factors affecting denaturation. Casein-whey protein interactions.

Molecular structures and isomers of lactose. Crystalline habits, hydrates, lactose glass, specific rotation, equilibrium of different isomers in solution, solubility, density, sweetness; hydrolysis; Oxidation; Reduction; Degradation with strong bases; Derivatives; Dehydration and Fragmentation; Browning reaction; Oligosaccharides in milk.

Major and minor minerals in Milk; Variation in salt composition of milk. Physical equilibrium amongst milk salts; salt balance ratio and its importance; protein-mineral interactions. Molecular structure of vitamins. Levels in milk and milk products. Factors affecting their levels; Biological significance; Relation with redox potential (Eh), carotenoids in milk. Analysis of fats, proteins, carbohydrates, vitamins and minerals in milk and milk products. FSSAI standards for milk products.

Unit II: Chemistry of Milk Processing (20 Questions)

Heat induced changes in milk; milk stone; Heat stability of concentrated milks; Age gelation; Physico-chemical changes during manufacturing and storage of concentrated milks; dried milks; Mechanism of action of stabilizers and emulsifiers; Changes during manufacturing and ripening of cheeses. Lactic acid fermentation in fermented dairy products. Ripening index. Chemical defects in cheese. Chemical mechanism of churning; Physico-chemical constants of ghee; Factors responsible for texture (grains) and flavour of ghee. Storage stability of cream, butter and ghee.

Unit III: Chemistry of Functional Dairy Foods and Nutraceuticals (20 Questions)

Functional milk proteins and their therapeutic potential, recent advances in their separation, Generation of bioactive peptides from casein and whey proteins, their isolation and characterization, colostrums as source of nutraceuticals. Conjugated linoleic acids (CLA) in milk, their variation, physiological effects and their importance in dairy foods. Omega-3 fatty acid and their health attributes. Mineral and vitamin fortification in milk and milk products.

Unit IV: Dairy Science (20 Questions)

Present status of Indian dairy industry - Operation flood program - Anand pattern – Modern Milking systems - Hygienic milk production - Milk Composition and factors affecting quality - Nutritive value - Platform tests, Adulteration of raw milk - Milk procurement and pricing policy - Operation and maintenance of primary milk co-operative society (PMCS) – milk analysers, estimation of milk fat and SNF - Raw milk chilling and BMC operation - Handling and transportation of milk to processing dairies and surveillance system – Composition of various dairy products including indigenous milk products - Methods of manufacture, quality attributes, shelf life, preservation, packaging of khoa, chhana and paneer - Basic principles of manufacture and quality aspects of cream - Butter manufacture and its defects - Methods of ghee making and its quality control. Manufacture of fresh and ripened cheese - Technological aspects of ice cream manufacture. Fermented milk products preparation - Location, design, arrangement of floor space and constructional details - Metal and materials used in dairy utensils and machinery - Inspection of premises and protection from contamination - General cleanliness and sanitation of plant. Washing and sterilization of dairy equipment, bottles and cans - Constructional and technical control methods and equipment used for manufacture of different milk products - Methods of disposal of dairy effluents. Role of hardness of water in the dairy industry - Lactogenesis and Galactopoiesis - Let down of milk - Systems of Dairy cattle breeding - Significance of mastitis and other diseases of economic importance - Management of milch animals, pregnant animals, dry animals, heifers and calves - Milk biosynthesis - Detailed composition of colostrums - FSSAI specification for milk.

Unit V: Analytical Techniques (20 Questions)

Acids and Bases: Bronsted and Lewis acids and bases - pH and pKa acid - base concept in non - aqueous media – Hard and Soft Acids and Bases (HSAB) concept - Buffer solutions. Redox reactions: Oxidation numbers, Redox potential, Electro chemical series – Application of Electro Motive Force (EMF) measurements - Redox indicators. Determination of pH and pKa of acids by potentiometric methods.

Titrimetric Analysis: Principles of titrimetric analysis - Standard solutions: Normality, Molarity and Molality - Concentration units - Primary and secondary standards - neutralization indicators - self indicators and external indicators - acid base titrations - precipitation titrations – redox titrations.

Gravimetric analysis: Principles of gravimetric analysis - requirement of gravimetric analysis - Precipitation: Theories of Precipitation. Types of precipitation – Co-precipitation, post precipitation - precipitation from homogeneous solution-digestion, filtration, washing, drying and ignition. Inorganic and organic precipitating agents.

Qualitative Analysis: Semimicro qualitative analysis of cations like Cu, Zn, Cd, Hg, Pd, As, Sn, Zr, Ca and Mg.

Water Analysis: Water quality parameters; physical, and chemical parameters – water quality analysis – dissolved oxygen, pH, salinity, turbidity, ammonia, nitrite, nitrate, alkalinity and hardness testing - Total dissolved solids (TDS) - Biological oxygen demand, (BOD), Chemical oxygen demand (COD) - conductivity testing – determination of chloride and sulphate by gravimetric methods.

Unit VI: Organic Chemistry, Instrumentation and Spectroscopy (20 Questions)

Organic Reaction Mechanism: General Methods (kinetics and non-kinetics) of study of reaction mechanisms - Methods of determining reaction mechanism – isotopic labelling – SN1 and SN2 mechanisms – addition, substitution, elimination reactions and rearrangements -free radical mechanism - aromatic substitution and stability of the reactive intermediate (Carbocations, Carbanion's free radicals, nitrates and benzyne) - Polar effects - Hammett's equation and its modification.

Instrumentation and Spectroscopy: Basic Principles, Instrumentation and applications of Ultraviolet - visible (UV-vis.) spectroscopy; Beer-Lambert's law, solution preparation and small molecules analysis and Flow Injection analyzer – Fourier Transformer Infrared Spectroscopy (FT-IR), Near Infrared spectroscopy (NIR) - Nuclear Magnetic Resonance (NMR) spectroscopy, Flame spectrometry, Atomic Absorption Spectroscopy (AAS), Inductively Coupled Plasma - Mass

Spectrometry (ICP-MS), Inductively Coupled Plasma Emission Spectroscopy(ICP-OES),

Chromatographic Techniques: Basic Principles of Chromatography, Instrumentation and application of chromatography – High - Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC), Gas-Chromatography with Mass Spectrometry (GC-MS), Liquid Chromatography with Mass spectrometry (LC-MS)

Unit VII: Biochemistry (20 Questions)

Composition and Physicochemical properties of Milk - Major components: proteins (casein, whey proteins), lipids (milk fat), carbohydrates (mainly lactose), vitamins, minerals, and water. Physicochemical properties: pH, buffering capacity, specific gravity, and thermal behaviour of milk constituents. Enzymes – Classification, activity and enzyme units. Enzymes in milk. Endogenous enzymes - lipase, protease, amylase, lactoperoxidase, catalase, alkaline phosphatase, and xanthine oxidase. Fermented products. Exogenous enzymes - Rennet (chymosin/rennin), lactase, lipase in ripened cheeses, Protease in yogurt and cheese ripening. Transglutaminase in product texture and stability. Rancidity in milk - free radicals formation. Factors influencing rancidity. Enzyme assays in monitoring spoilage, mastitis detection, and adulteration. Molecular approaches in milk quality control - PCR-based identification of *Salmonella spp.*, *Listeria monocytogenes*, *Escherichia coli*, *Mycobacterium spp.*

Unit VIII: Biotechnology and Microbiology of Milk and Dairy Products (20 Questions)

Cell ultra - structure - prokaryotes and eukaryotes; Importance of bacteria, yeasts and moulds, viruses and phages in dairy foods; Bacterial growth: Growth phases and kinetics; factors affecting bacterial growth; Growth measurement; sporulation; Bacterial nutrition.

Common microbes in milk and their significance, Microflora of mastitis milk, Sources of microbial contamination of raw milk during collection, transport and storage; Clean milk production, natural antimicrobial systems in raw milk; Microbial changes in raw milk during long storage, Microbiological grading of raw milk; Microbiological aspects of processing techniques - bactofugation, thermization, pasteurization, sterilization, boiling, UHT and non-thermal processes including membrane filtration; Role of psychrotrophic, mesophilic, thermophilic and thermotolerant bacteria in spoilage of processed milks, their sources and prevention; Heat induced damage in bacteria and role of resuscitation in recovery of injured microbial cells.

Microbiological quality of dairy products - fat rich, frozen, concentrated, dried milks, fermented, and indigenous dairy products; Legal standards; Sources of contamination and factors affecting microbial quality of these products during processing, storage and distribution; Microbiological defects associated with these products and their control; Food poisoning; infections and their public health significance; Sources of pathogens and their prevention.

Dairy starter cultures - Classification of starters; propagation and preservation of starter cultures (liquid, freeze drying and other methods); factors affecting propagation of starter cultures. Commercial starter preparations: concentrated and super concentrated starters;

Genetically Modified Organism (GMO), Genetically Modified (GM) foods and their safety from public health point of view; Probiotics, Prebiotics and synbiotics - concepts; Probiotic based functional dairy foods/ health foods and nutraceuticals; Nutrigenomics.

Unit XI: Dairy Plant Hygiene and Sanitation (20 Questions)

Environmentally transmitted microbial pathogens (*Salmonella*, *E. coli*, *Campylobacter*, *Yersinia* etc.) and viruses (enteric and respiratory); indicator microorganisms - total and faecal coliforms, faecal streptococci, bacteriophage etc; Biofouling and biofilms; microbial toxicants and bio-organic pollutants; Waste water treatment: physical; biological unit operations - aerobic and anaerobic cycles; kinetics of biological growth, application of kinetics to treatment systems, aerobic waste treatment, anaerobic waste treatment; tertiary treatment - waste water utilization and disposal. Air quality monitoring;

Growth inhibition of lactic acid bacteria by antibiotics, bacteriocins, bacteriophages, cleaning and sanitizing agents and naturally occurring antimicrobial systems in raw milk; Examination of purity and activity of starter cultures.

Current trends in cleaning and sanitization of dairy equipment; Methods of cleaning and sanitization - Hand washing, Mechanical washing, and Cleaning In Place (CIP). Automation, Ultrasonic techniques in cleaning; Bio-films; Bio-detergents, innovations in sanitizers - chemical, radiation; Assessing the effectiveness of cleaning and sanitization of dairy equipment; Characterization of dairy and food industrial waste waters including Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD); Detection of residual antibiotics / pesticides in waste water samples.

Unit X: Microbial Food Safety and Quality Assurance (20 Questions)

Principles of quality and safety functions in dairy processing unit; FSSAI - regulations and guidelines; ISO standards; principles of Quality Management System (QMS) and Hazard Analysis Critical Control Point (HACCP), SAFE, Good Manufacturing Practices (GMP), System Standard Operating Procedure (SSOP), Food Safety Management System (FSMS), personnel hygiene and food handling in dairy industry; Bio-safety concepts - Sampling plan as per International Council for Microbiological Standards for Foods (ICMSF); Guidelines and specifications for different dairy foods as recommended by International Council for Microbiological Standards for Foods (ICMSF), Codex Alimentarius Commission (CODEX).

Enumeration of composite micro flora in milk and dairy products - aerobic & anaerobic; Conventional detection methods for indicator organisms – Standard Plate Count (SPC), coliforms, E. coli, yeast and mould (YMC), spore; enterobacteriaceae; Faecal streptococci; Dye reduction tests; Rapid techniques like D-count, Petrifilm, ATP bioluminescence including Tempo, VIDAS, SPR, RT-PCR and commercial kits, for monitoring safety indicators; Bio-sensors and micro-techniques for rapid monitoring of contaminants-antibiotics, pesticides, heavy metal, aflatoxin; Microscopy - Staining: simple, differential and special staining; Spectrophotometry, ELISA, protein and enzyme assays, microbiological assay, and microbial receptor assay; Quality requirements of water for dairy plant operations.

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