

# **TAMIL NADU PUBLIC SERVICE COMMISSION**

## **SYLLABUS**

### **DAIRY CHEMISTRY (PG Degree Standard)**

**CODE: 468**

#### **UNIT I: PHYSICO-CHEMICAL ASPECTS OF MILK CONSTITUENTS**

Definition of Milk as per FSSAI and average Composition of milk from cow, buffalo and other species. Structural Elements of Milk: Fat Globules, Casein Micelles, Globular Proteins, Lipoprotein Particles and their Properties and Grading of Milk. Basics of chemical reaction kinetics - Order and molecularity - 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 milk products and its relation to stability of dairy products; foams and emulsions; micelles and gelation

#### **UNIT II: CHEMISTRY OF MILK LIPIDS**

Classification of milk lipids. Composition of milk fat globule membrane. Factors affecting the profile of fatty acids – different properties of fatty acids – unsaponifiable matter and its importance – composition, level and physiological functions; chemical properties of milk lipids –hydrolysis, hydrogenation, halogenation, transesterification; Oxidation of milk fat – auto-oxidation, antioxidants and thermal oxidation of fat.

#### **UNIT III: CHEMISTRY OF MILK PROTEINS**

Nomenclature of milk proteins; genetic polymorphism and biological significance of the chief milk protein-Casein, its methods of isolation, fractionation and heterogeneity; amino acid composition; Casein micelle models; Primary structure of different caseins; Modification of casein:

Physical, chemical (glycosylation, phosphorylation) and enzymatic. Minor milk proteins - Whey proteins - alpha-lactalbumin and beta-lactoglobulin, bovine serum albumin: 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; Enzymes - Indigenous milk enzymes: Properties and their significance

#### **UNIT IV: CHEMISTRY OF LACTOSE**

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

#### **UNIT V: CHEMISTRY OF MINERALS AND VITAMINS**

Minerals in Milk: major and minor minerals; Factors affecting salt composition of milk; Distribution and importance of trace elements in milk. Physical equilibrium amongst milk salts; partitioning of salts; salt balance, 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; Ascorbic acid - structure; Relation with redox potential (Eh) of milk and milk products, carotenoids in milk

#### **UNIT VI: CHEMISTRY OF PROCESSING OF MILK AND DAIRY PRODUCTS**

Heat induced changes in milk; milk stone; Heat stability of concentrated milk; Age gelation; Physico-chemical changes during manufacturing and storage of concentrated milk; dried milk; Mechanism of action of stabilizers and emulsifiers in ice cream; Changes during manufacturing

and ripening of cheese;. Lactic acid fermentation in cheese and other fermented dairy products. Chemical defects in cheese. Factors affecting creaming phenomena; mechanism of churning; grading and standards of butter; Physico chemical constants of ghee; Factors responsible for texture (grains) and flavour of ghee. Storage stability of cream, butter and ghee.

## **UNIT VII: CHEMISTRY OF FUNCTIONAL DAIRY FOODS AND NUTRACEUTICALS**

Bio-functional milk proteins and their therapeutic potential, recent advances in their bio-separation, Phyto-chemicals, Generation of bioactive peptides from casein and whey proteins, their isolation and characterization, colostrums as source of nutraceuticals. Technological and nutritional aspects of milk lipids, conjugated linoleic acids (CLA) in milk, their variation, physiological effects and their importance in dairy foods. Omega-3 fatty acid and their health attributes, strategies to reduce the cholesterol in dairy products. Mineral and vitamin fortification in milk and milk products

## **UNIT VIII CLEANING AND SANITIZATION IN DAIRY PLANTS**

Current trends in cleaning and sanitization of dairy equipment; Desirable properties of detergents and sanitizers; commonly used detergents and sanitizers; Determination of temporary and permanent hardness of water. Estimation of residual chlorine in water. Strength of common detergents and sanitizers used in dairy plant. Methods of cleaning and sanitization: (i) Hand washing (ii) Mechanical washing (iii) Cleaning In Place. Automation, Ultrasonic techniques in cleaning; Bio-films; Bio-detergents, innovations in sanitizers - chemical, radiation; Mechanism of fouling and soil removal; Assessing the effectiveness of cleaning and sanitization of dairy equipment.

## **UNIT IX: CHEMICAL QUALITY ASSURANCE IN DAIRY INDUSTRY**

Chemical composition and legal standards of milk products - Quality assurance and quality control in dairy industry; quality management systems; Hazard Analysis and Critical Control Points (HACCP); Good Manufacturing Practices (GMP); Good Laboratory Practices (GLP); various standards pertaining to the chemical quality of milk and milk products - ISO 9000; Total Quality Management (TQM); role of international organisations such as ISO; IDF; CAC; AOAC; WTO and national organisations like FSSAI, BIS, AGMARK, EIA and APEDA (Agricultural and Processed Foods Export Development Authority) in dairy industry.

## **UNIT X: ANALYTICAL PROCEDURES AND TECHNIQUES IN DAIRY CHEMISTRY**

Preparation of standard solutions and reagents for various chemical analyses of milk and dairy products. Checking the accuracy of calibration of hydrometers/ lactometers, butyrometers, milk pipette and thermometer. Sampling techniques of chemical examination of milk and dairy products. Determination of pH and titratable acidity of milk. Determination of fat in milk and dairy products by different methods. Determination of total solids and solids not fat in milk. Determination of total milk proteins by Kjeldahl method. Determination of casein, whey proteins and NPN in milk. Estimation of alkaline phosphatase and lipase in milk. Determination of lactose in milk. Determination of ash in milk. Determination of phosphorus and calcium in milk. Determination of chloride in milk. Assessment of homogenisation efficiency in milk. Detection of adulterants and preservatives in milk and milk products; Detection of agrochemicals, microbial toxins, antibiotic residues, heavy metals, radionuclides in milk and dairy products. Sampling and chemical examination of pasteurized, sterilized and UHT processed milk. Chemicals examination of concentrated and dried milks including Dairy whitener for Moisture, Total Solids, acidity, fat, lactose, bulk density and solubility index. Grading and quality of raw milk for condensed and evaporated milk. Sampling, determination of melting/slip point, moisture of ghee by

gravimetric method, B.R. Index and Baudouin Test. Acidity, Helphen Test for the presence of cotton-seed oil. R.M. value and Polenske value. Saponification value. Iodine value. Peroxide value. Detection of animal body fats and vegetable oils. Examination of the quality of sodium chloride for butter making. Automated milk analysers. Flavour, Colour and texture profiling of dairy products. Electrophoresis: principle and types, isoelectric focussing. Column Chromatography, TLC, GLC, HPLC, GC-MS, LC-MS, ICPMS, gel-permeation, ion-exchange, affinity chromatography Spectrophotometry: UV, visible, IR and flame photometry; potentiometry: principle, various electrodes; buffers. Immunobased analytical techniques such as ELISA & Lateral flow assay Separation of bio-molecules using membranes; ultracentrifugation. NMR (Nuclear Magnetic Resonance), FTIR (Fourier Transform Infrared)-Principle, application for quality analysis of milk and dairy products. Measurement of BOD and COD in dairy effluent.