NEW AND RESTRUCTURED
POST-GRADUATE CURRICULA & SYLLABI

Dairy Technology

Education Division
Indian Council of Agricultural Research
New Delhi
Salient Features

- A new course introduced on “Traditional and value-added dairy products” thereby elevating the traditional dairy products to the PG programs.


- The doctoral-level course “Product-Process Monitoring” has been revamped with respect to the title and contents. This “Product monitoring & process control” course gives an insight into the novel analytical and processing dimensions of the modern food industry.

- The new courses introduced at master’s level will require additional infrastructure in terms of equipment for conducting the practical classes, without which it will end up being the same as it was under the old syllabus.

- Also, HRD training in the areas of new technologies and new instrumental techniques will be indispensable in implementation of the new curricula.
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* Compulsory for Master’s programme.

**NOTE:** *Doctoral students shall take a minimum of two 700-level courses.*
DETAILED COURSE CONTENTS

DT-611 ADVANCED DAIRY PROCESSING (3 + 1)

Objective

To provide in-depth knowledge in various unit operations and basic concepts in dairy processing.

Theory

Unit 1
Use of bio-protective factors for preservation of raw milk: effects on physicochemical, microbial and nutritional properties of milk and milk products, present status of preservation of raw milk by chemical preservatives; thermal processing for preservation.

Unit 2
Methods of determining lethality of thermal processing, UHT processed milk products, their properties and prospects, types of UHT plants, aseptic fillers, heat stability and deposit formation aspects, effect on milk quality; techno-economic considerations; retort processing.

Unit 3
Principles and equipment for bactofugation and Bactotherm processes, Microfluidization of milk: Principle, equipment, effects and applications, Homogenization and their applications in dairy industry.

Unit 4
Dehydration: advances in drying of milk and milk products; freeze concentration, freeze dehydration: physicochemical changes during freeze drying and industrial developments.

Unit 5
Water activity; sorption behaviour of foods, energy of binding water, control of water activity of different milk products in relation to their chemical; microbiological and textural properties; hurdle technology and its application in development of shelf-stable and intermediate-moisture foods, Use of carbonation in extending the shelf life of dairy products.

Unit 6
Current trends in cleaning and sanitization of dairy equipment: biological; detergents; Automation; Ultrasonic techniques in cleaning; bio-detergents, development of sanitizers- heat; chemical; radiation, mechanism of fouling and soil removal; Bio-films, assessing the effectiveness of cleaning and sanitization of dairy products.

Practical

LP system for extension of keeping quality raw milk, determination of pH; HCT profile of milk systems, measurement of thiocyanate in milk system; determination of water activity and sorption isotherms of milk products; determination of thermal load during retort processing of milk and milk products; heat classification of milk powders; functional properties of powders: porosity, interstitial air content, occluded air content, flowability; determination of degree of browning-chemical/physical methods; freeze drying of
milk/milk products, and heat sensitive products. Homogenization efficiency; cleaning efficiency in dairy equipment; visit to a UHT Processing plant. Thermal process calculations.

**Suggested Readings**

**DT-612 ADVANCED FOOD PROCESSING (3 + 1)**

**Objective**
To provide in-depth understanding of advances in theoretical and practical aspects of food processing.

**Theory**

**Unit 1**
Status of food processing industry in India and abroad; prospects and constraints in development of Indian food industry.

**Unit 2**
Post harvest management of fruits and vegetables, Harvesting indices, Biochemical and physical changes during ripening of fruits & vegetables, respiration and factors affecting it, role of ethylene in accelerated ripening, post harvest treatments for extension of shelf-life of fresh produce, Strategic interventions to minimize post harvest losses including vapour heat treatment, wax coating, chemicals, etc.

**Unit 3**
Principles of chilling & refrigeration storage of foods, quality changes in cold stored products, controlled and modified atmospheric storage. Freezing of foods, principle and
equipments for freezing, defects in frozen foods, re-crystallization, freezing of fruits and vegetables, freeze concentration of fruit juices.

Unit 4
Application of heat energy to foods for preservation and processing, concept of drying rate of foods, industrial drying processes of foods; changes during drying, advanced drying processes (Freeze drying, infra red drying and microwave drying), Canning of fruits & vegetables, unit processes involved in canning, types of cans for thermal processing of foods.

Unit 5
Basic principles involved in fermentation, Technological aspects of pickled vegetables like sauerkraut, cucumbers, Technology of wine, beer and distilled alcoholic beverages, defects in alcoholic beverages.

Unit 6
Conversion of muscle into meat, rigor mortis, freezing and canning of meat, curing & smoking of meat, fermented sausages, cooking of poultry, utilization of milk ingredients in processed meat and poultry products.

Unit 7
Advances in milling of rice (solvent extractive milling) and Turbo milling of wheat. Bakery products; role of ingredients, Developments in manufacturing processes for bakery products such as breads; biscuits; pizza bases, cake etc; changes during processing of bakery products. Utilization and importance of dairy ingredients in bakery products.

Unit 8
Definition, classification and technologies of fabricated and formulated foods and their nutritional aspects. Imitation dairy products and dairy analogues. Principle of extrusion processing, design and working of extruder, classification, application in food and dairy processing. Food additives, including stabilizers, emulsifiers, antioxidants, preservatives, etc. for formulated foods.

Unit 9
Important group of enzymes involved in food processing; Application of enzymes in food processes like enzymes juice extraction, juice clarification, in bread manufacture, meat tenderization, ice cream manufacture, de-sugaring of egg, etc.

Unit 10
Newer concepts in food processing including organic foods, processing of organic raw material, genetically modified foods.

Practical
MAP and its effect on shelf-life of fresh fruits and vegetables, Preparation of squash, cordial, nectar and whey beverages, whey based soups, Manufacture of bread, pizza base, biscuits and cake, Application of milk ingredients in caramel, egg-less cake, mayonnaise, canning of fruits & vegetables, manufacture of chicken soup, comminuted meat products, enzymatic extraction and clarification of fruit juices, Preparation of soymilk and tofu, Drying of fruits & vegetables, efficacy of blanching treatment. Manufacture of sauerkraut/fermented vegetables.
Suggested Readings

DT-613 RHEOLOGY OF DAIRY & FOOD PRODUCTS   (2 + 1)

Objective
To explain the basics of food rheology, and to familiarize the students with rheological instruments and their use in relation to dairy and food products.

Theory

Unit 1
Introduction to rheology of foods: Definition of ‘texture’, ‘rheology’ and ‘psychophysics’ – their structural basis; physical considerations in study of foods; salient definitions – Stress tensor and different kinds of stresses.

Unit 2
Rheological classification of Fluid Foods: Shear-rate dependence and time dependence of the flow-curve; Non-Newtonian fluids; thixotropy; Mechanisms and relevant models for non-Newtonian flow; Effect of temperature; Compositional factors affecting flow behaviour; Viscosity of food dispersions – dilute and semi-dilute systems, concentration effects.

Unit 3
Comparative assessment of different types of Viscometers, and their Merits and Limitations: Co-axial cylinders, Spindle- or Impeller-type viscometers, Cone-plate viscometer, Capillary viscometers, Falling-sphere viscometer, Vibratory viscometers, Extrusion viscometer, Orifice viscometer.

Unit 4
Rheology of semi-solid and solid food ; Rheological characterization of foods in terms of stress-strain relationship; Viscoelasticity; Transient tests - Creep Compliance and Stress Relaxation; mechanical models for viscoelastic foods: Maxwell, Kelvin, Burgers and generalized models and their application; Dynamic measurement of viscoelasticity.

Unit 5
Large Deformations and failure in foods: Definitions of fracture, rupture and other related phenomena; Texture Profile Analysis; Instrumental measurements – Empirical and Fundamental methods; Rheometers and Texture Analyzers; Measurement of Extensional viscosity; Acoustic measurements on crunchy foods.

Unit 6
Rheological and textural properties of selected dairy products: Measurement modes and techniques; Effect of processing and additives (stabilizers and emulsifiers) on food product rheology; Relationship between instrumental and sensory data.

Practical
Study of different types of viscometers viz., co-axial cylinder viscometer, spindle viscometer, falling-ball viscometer, extrusion viscometer, impeller viscometer, orifice viscometer; Flow behaviour of fluid dairy products; Thixotropy in ice-cream mix; force-deformation study in selected dairy products using Texture Analyzer; Back extrusion; Effect of test conditions on the texture profile parameters of cheese and similar products; stress relaxation studies in solid foods; Use of Cone Penetrometer and FIRA-NIRD extruder for measurement of butter texture; Use of a Viscoamylograph for study on the gelatinization behaviour of starch/cereals flours.

Suggested Readings

DT-614 DAIRY PROCESS BIOTECHNOLOGY (2 + 1)

Objective
To project the importance of biotechnology in dairy processing and impart knowledge on all aspects of dairy process biotechnology in production and preservation of dairy products employing the principles of biotechnology.

**Theory**

**Unit 1**
Definition of biotechnology; development and impact of biotechnology on food and dairy industry.

**Unit 2**
Microbial rennet and recombinant chymosin, characteristics and application in cheese making; exogenous free and microencapsulated enzymes, immobilized enzymes-their application in accelerated ripening of cheese; enzymatically modified cheeses (EMC) their utilization in various food formulations.

**Unit 3**
Technological requirements of modified micro-organisms for production of cheese and fermented milk products; technological innovations in the development of functional dairy foods with improved nutritional therapeutic and pro-biotic attributes; physiologically active bio-peptides/ nutraceuticals; protein hydrolysates – their physicochemical, therapeutic properties, production and application in food formulations; production of bio-yoghurt, pro-biotic cheese and fermented Milks; bifidus factors in infant food formulations.

**Unit 4**
Protein hydrolysates-production, their physicochemical, therapeutic properties, de-bittering and application in food formulations; Enzymatic hydrolysis of lactose for preparation of whey and UF-permeate beverages.

**Unit 5**
Microbial polysaccharides their properties and applications in foods, production of alcoholic beverages and industrial products from starch; whey and other by-products; bio-sweeteners-types properties and their applications in dairy and food industry.

**Unit 6**
Bio-preservatives- characteristics and their application in enhancing the shelf life of dairy and food products.

**Practical**
Effect of exogenous enzymes on hydrolysis of protein and fat in culture containing milk systems; to study the various factors affecting the coagulation of milk by microbial rennets. Manufacture and evaluation of pro-biotic cheese and fermented milks; determination of glycolysis, proteolysis and lipolysis in cheese and fermented milk; enzymatic process for manufacture of low lactose milk whey products; preparation of casein hydrolysis; visit to a bio-processing unit.

**Suggested Readings**

**DT-615 TRADITIONAL AND VALUE-ADDED DAIRY PRODUCTS**

(2 + 1)

**Objective**
To project the significance and status of traditional and value added dairy products in Indian dairy industry.

**Theory**

Unit 1
Present status of traditional dairy products; globalization of traditional dairy products; plans and policies of the Government and developmental agencies.

Unit 2
Process schedule of heat-desiccated, coagulated and fermented traditional dairy products; process improvement in production of milk sweets.

Unit 3
New products based on fruits, vegetables and cereals; application of membrane technology; microwave heating for industrial production of traditional dairy products.

Unit 4
Advances in industrial production of ghee, flavour and texture simulation.

Unit 5
Techno-economic aspects for establishing commercial units for traditional products.

Unit 6
Convenience traditional dairy products; use of natural and permitted synthetic preservatives and new packaging systems.

**Practical**
Microwave heating of traditional milk delicacies for shelf life extension; application of membrane technology for improving the quality of traditional products from cow and buffalo milk; preparation of feasibility report for establishing commercial units for traditional products.

**Suggested Readings**

DT-616 ALTERNATIVE PROCESSES FOR DAIRY (2+1) & FOOD INDUSTRY

Objective
To develop an understanding of the basic principles underlying the novel/non-conventional food processing techniques, equipment required, features and actual and potential applications.

Theory
Unit 1
Irradiation: sources and properties of ionizing radiation; mechanism of interaction with microorganisms and food components microbial inactivation in dairy and food products, chemical effects, packaging, industrial irradiation systems, benefits and limitations; safety aspects, national and international regulations.

Unit 2
High frequency heating: Principles of dielectric heating and factors affecting it, design and working of microwave oven, continuous microwave heating units, applications in dairy and food processing, microwavable packaging safety aspects of microwaves, merits and demerits of dielectric heating.

Unit 3
Infra-red heating: Interaction of infra-red (IR) radiation with penetration properties, equipment; dairy and food application, advantages and disadvantages of IR heating.

Unit 4
Ohmic heating: Principle of electric resistance heating, design of an ohmic heater, operational variables, power considerations, factors affecting heating efficiency, merits and limitations, food applications and future scope.

Unit 5
Ultrasonic treatment of food: Mechanism of ultrasound induced cell damage, generation of ultrasound equipment, design of power ultrasonic system, types of ultrasonic reactors, application of power ultrasound in food processing, effects on food constituents,
ultrasound in consideration with other process alternatives - thermosonication, advantages and future prospects.

Unit 6
High hydrostatic pressure processing: Principle of microbial inactivation, barotolerance of microorganisms, effect on food constituents, equipment dairy and food application, merit and demerits.

Unit 7
Pulsed electric field processing: Description/ mechanism and factors affecting microbial inactivation effects on food components; present status and future scope for food applications.

Practical
Study of a microwave oven; Determination of power output of a microwave oven; Temperature profile in a microwave oven cavity; Microwave absorption by various food packaging materials; Heating behaviour of water, milk, cream and other milk products – effect of composition; Shelf-life extension of pasteurized milk employing microwave heating; Effect of shape and size of water/milk container on microwave heating; Cooking of ‘instant’ products in a microwave oven; Drying of casein, ‘instant’ wheat, ‘instant’ rice, etc.in a microwave oven; Miscellaneous food processing/heating applications of microwaves; Visit to a commercial food irradiation facility.

Suggested Readings

DT-621 MEMBRANE TECHNOLOGY IN DAIRY PROCESSING (2 + 1)

Objective
To explain the basics of membrane technology and its applications in dairy processing.

**Theory**

**Unit 1**
Membrane techniques: classification and characteristics of filtration processes; types of membranes commercially available; membrane hardware, design of membrane plants, modeling of ultrafiltration (UF) processes, mass transfer model, resistance model; membrane fouling problem and treatment, cleaning and sanitization of different types of membranes.

**Unit 2**
Factors affecting permeate flux during ultrafiltration and reverse osmosis of milk and sweet and sour whey, energy requirements for processing of milk and whey.

**Unit 3**
Applications of ultrafiltration, reverse osmosis, nanofiltration and microfiltration in the dairy industry. Developments in the manufacture and utilization of food and pharmaceutical grade lactose from UF permeate. Preparation of special foods like low lactose powder and dairy whiteners using UF retentate, whey protein concentrates, casein and coprecipitates.

**Unit 4**
Demineralisation: Importance of demineralisation, different processes available for demineralization: their principle, plant and operation.

**Unit 5**

**Practical**
Study of the effect of types of milk, temperature of milk and trans-membrane pressure on the permeate flux during ultrafiltration process; performance of ultrafiltration membrane with respect to permeate flux and volume concentration ratio during processing of acid and sweet whey; study the effect of types of milk, temperature and applied pressure on the permeate flux during the reverse osmosis process; nanofiltration of milk, whey and permeate; microfiltration of skim milk and whey; preparation of whey protein concentrate and its utilization in dairy products; measurement of different functional properties of casein and whey protein: whipping ability; water binding; emulsification properties; gelling; viscosity and solubility.

**Suggested Readings**
DT-622 ADVANCED DAIRY AND FOOD PACKAGING (2 + 1)

Objective
To impart basic and advanced knowledge of dairy and food packaging.

Theory

Unit 1
Status of current packaging; types of packaging materials; criteria for selection of proper packaging; testing of packaging materials.

Unit 2
Adhesives; graphics; coding, and labeling used in food packaging.

Unit 3
Protective packaging of foods; packaging of food products sensitive to oxygen, light, moisture; Active packaging; special problems in canned foods.

Unit 4
Packaging of dairy products; packaging of convenience foods, packaging of fruits, vegetables, and fruit juices.

Unit 5
Packaging of fats and oils; packaging of spices; packaging of meat and poultry: packaging of fish and other seafoods.

Unit 6
Modified atmosphere packaging, Controlled atmosphere packaging, Shrink and stretch packaging.

Unit 7
Retort pouch technology, microwavable, biodegradable, and edible packages.

Unit 8
Industrial packaging: unitizing, palletizing, containerising, distribution systems for packaged foods including prevention of shock damage to articles during transportation.

Unit 9
Safety aspects of packaging materials; sources of toxic materials and migration of toxins into food materials.

Practical
Testing of packaging materials for quality assurance like determination of thickness, GSM, grease resistance, bursting strength, tearing resistance, WVTR, puncture resistance; estimation of shelf life of vegetables and seasonal fresh fruits; packaging of turmeric powder and ground red chilli powder, vacuum packaging of dairy products.

Suggested Readings
DT-623 TECHNOLOGY OF FOOD EMULSIONS, FOAMS & GELS (2+1)

Objective
To impart basic knowledge regarding food dispersion systems, their formation, behaviour, and factors affecting their stability.

Theory
Unit 1
Food dispersions, their characteristics and factors affecting food dispersions.

Unit 2
Food emulsions; emulsifiers and their functions in foods; the HLB concept in food emulsifiers; emulsion formation and stability; polymers and surfactants.

Unit 3
Milk foams and their applications, structure of foams, egg foams and uses, foam formation and stability.

Unit 4
Theory of gel formation; pectic substances and jellies; fruit pectin gels; milk jellies.

Unit 5
Structure of dairy foods representing emulsions, foams and gels; physical structure of fat rich, concentrated, fermented, coagulated and dried products.

Unit 6
Techniques for evaluation of structure for food emulsions, foams and gels.

Practical
Determination of the rate of formation and stability of emulsions; Emulsifying properties of milk proteins and other food ingredients; Properties of different types of emulsifiers and their role in food emulsions; Examination of foam formation and determination of...
foam stability; Milk proteins and other food ingredients in food foams; foaming in dairy systems; Studies on gel formation and gel properties; Food gels – Gelatin-based, pectin-based, etc.; Properties of various gelling agents for foods.

**Suggested Readings**

**DT-624 FUNCTIONAL FOODS & NEW PRODUCT DEVELOPMENT**

**Objective**
To impart the knowledge of functional ingredients, nutraceuticals and their utilization in development of new food products including health foods, functional foods and specialty foods.

**Theory**

**Unit 1**
Definition, classes of functional foods, status of functional foods in world and India. Concept of new product development, classed of nutraceuticals and functional foods. Safety; marketing strategy and consumer response; economic analysis and costing of novel foods, recent advances in different categories and type of dairy product.

**Unit 2**
Nutritional status and dietary requirement of different target group and deficiency diseases, in special reference to micronutrients. Dietary and therapeutic significance of dairy nutrients, bioactive components in dairy products like lactose, whey proteins, milk minerals, CLA, fermented milks etc.

**Unit 3**
Food fortification, techniques for fortifying dairy foods with minerals and vitamins, High protein foods prospective nutraceuticals for fortification of dairy foods. Nutritional significance of dietary fibers, classes of dietary fibers, fortification techniques for fibers in dairy foods.

**Unit 4**
Infant nutrition and dietary Formulations for meeting normal and special needs of infants, current status of infant foods, additives for infant foods. Foods for aged persons, design consideration, ingredients for geriatric foods.

**Unit 5**
Technological aspects of reduced calorie foods, alternatives for calorie reduction, low calorie sweeteners, bulking agents and their application, fat replacers and their utilization in low calorie dairy foods.

Unit 6

Unit 7
Sports foods, ingredients for sports foods, dairy components in sports foods, sports drinks, design consideration, ergogenic aids in sports nutrition.

Unit 8
Herbs, various classes of herbs, their therapeutic potential and application in foods with special reference to dairy products like functional drinks, herbal ghee etc.

Unit 9
Prebiotic substances and their utilization in functional foods, symbiotic foods, technological aspects and recent development in probiotics, prebiotics and synbiotics.

Unit 10
Definition and various classes of phytochemicals, their role in CVD, Cancer and immune system enhancer, utilization in functional foods, phytosterol, phytoestrogens, glucosinolates, organosulphur compounds, flavonoids, carotenoids, etc.

Unit 11
Special foods/nutrients for CVD, Cancer, IBD, diabetics, persons suffering with milk allergy and lactose intolerance with special emphasis on dairy nutrients and foods.

Practical
1. Determination of total fiber, neutral detergent fiber in foods
2. Manufacture of fiber enriched milk beverage
3. Manufacture of low calorie burfi/ice cream
4. Preparation of flavoured milk using artificial sweetener and its estimation
5. Determination of antioxidant activity of food/food components
6. Determination of bioavailability of nutrients
7. Development of malted milk food and weaning food
8. Determination of β-galactosidase activity and application of lactases for lactose free dairy products
9. Determination of prebiotic potential of certain plant/milk components and their application in synbiotics dairy foods
10. Preparation of sports beverage, herbal dairy drinks
11. Preparation of high protein products

Suggested Readings
**Objective**
To explain the physicochemical and nutritional characteristics of fats and oils, and their processing and utilization for food purposes.

**Theory**

**Unit 1**
Current Trends in the fats & oil Industry in India and abroad: Sources and utilization of animal, vegetable and marine fats/oils - An overview.

**Unit 2**
Basic chemistry structure aspects of fats and oils in general, and milk-fat in particular, in relation to their processing, properties, utilization and significance in human diet.

**Unit 3**
The changing concepts in the role of edible fats and oils in human nutrition and health: PUFA, MUFA, CLA, Omega fatty acids, Trans fatty acids, Phytosterol, etc.

**Unit 4**
Sources and classification of commercial edible fats and oils : Innovations in the production and processing of oils and fats from different sources, e.g. animal, plant, marine and microbial lipids for utilization in the dairy and food products; Non-conventional fats/oils for edible purpose – rice bran oil, microbial lipids.

**Unit 5**
Advances in refining including degumming, bleaching and deodorization oils and fats – Existing technologies and new developments - application of membrane techniques; Winterization.

**Unit 6**
Physico-chemical properties of oils & fats; Polymorphism, crystallization kinetics; New antioxidants.

**Unit 7**
Modification of fats and oils: Physical modification – Fractionation; Chemical modification – Hydrogenation and Interesterification; enzymatic/microbial modification of fats/oils; Cholesterol reducing treatments.

**Unit 8**
Applications of fats and oils: Margarine and low-fat table spreads; Bakery and confectionery fats; Coatings; Shortenings; Salad dressings; Technology of cooking oils, salad oils and oil based dressings; Frying process and systems; Changes in fats and oils during frying; Snack foods - Processing systems; Modified fats and oils for use in bakery and confectionery products, shortenings and spreads.

**Unit 9**
Fat replacers, technological developments in low calories spreads and other fat-based products.

**Unit 10**
Advances in technologies for production of plasticisers, emulsifiers and protective coatings.

Suggested Readings

DT-712 ADVANCES IN PROTEIN TECHNOLOGY (3+0)

Objective
To explain the characteristics of food proteins and to familiarize students with their implications in processing, their interactions in food systems and their nutritional role.

Theory

Unit 1
Characteristics of proteins from plant, animal and microbial origins.

Unit 2
Denaturation of proteins: Effect of processing parameters on denaturation. Effect of denaturation on the physicochemical and biological properties of proteins in food systems.

Unit 3

Unit 4

Unit 5
Protein hydrolysates-- Production and processing; De-bittering of protein products; Bioactive peptides: their production and properties.

Unit 6
Recent Technologies: Augmentation of world resources for protein foods: protein from plants, animals and microorganisms.

Unit 7
Textured vegetable proteins and spun fibre technology: Extrusion cooking- selection of ingredients and formulation, control of operational parameters, microstructure of extrusion cooked foods.

Suggested Readings

DT-721 PRODUCT MONITORING & PROCESS CONTROL (3+0)

Objective
To develop the understanding of the concept of monitoring and optimization of food quality/characteristics and familiarize the students with the techniques involved.

Theory
Unit 1

Unit 2
Process Control: Objectives; Control loop – Loop elements and their functions; Modes of process control; Control techniques; control equipment.
Unit 3
Real-time Instrumentation: Sensors; their classification based on Proximity, working principle; examples of applications in process control; Requirements of on-line sensors; Biosensors – Construction, types, working principles, applications, merits and limitations; Time-temperature indicators – partial-history & full-history indicators; Commercial devices; Applications and limitations; E-Nose & E-Tongue – Simulation of natural organs; Components & their functions; Applications.

Unit 4
Flavour analysis: Flavour bioassays – Gas Chromatography-Olfactometry techniques; Isolation, Separation and detection/Identification of flavour compounds – GC-MS, LC-MS, NMR, FTIR; analysis of chiral compounds.

Unit 5
Formation of flavour compounds in milk and milk products during heat processing (including UHT processing, caramelization and extrusion cooking), fermentation and ripening (cultured, products and cheese flavour, with special reference to bitterness) and storage (Maillard browning); Aroma losses/retention during the drying process (in relation to milk powder, cheese powder and dry cultured products); Industrial processes for extraction of desirable and undesirable volatile components from fresh and/or stored products by supercritical fluid (SCF) technique.

Unit 6
Monitoring of Food Structure: (a) Application of Thermal Analysis (DTA and DSC vis-avis dilatometry) and Pulse Nuclear Magnetic Resonance (PNMR) spectroscopy in determination of solid-fat content (SFC) of butter in relation to various processing and storage aspects; Glass transitions in dairy products; Starch gelatinization.

Unit 7
Monitoring of Food Structure: (b) Elucidation of crystal characteristics of milk fat in ghee and other fat-rich products by means of X-ray Crystallography with reference to the impact of cooling and storage/handling conditions on the crystal nature and product texture; Process-induced changes in sub-microscopic particulate properties of milk products; structure-texture relationship.

Unit 8
Monitoring of Food Structure: (c) Influence of heat processing and freezing treatments on protein denaturation and other conformational as well as aggregation-disaggregation phenomena as monitored through Spectropolarimetry, Circular Dichroism and related techniques.

Unit 9
Monitoring of Food Structure: (d) Particle-size analysis: Image analysis; Dynamic light scattering; Laser diffraction; Sieving, and other techniques.

Unit 10

Unit 11
Ultrasound in product monitoring: Speed- and Attenuation-based measurements of
liquid levels, density, mass flow, etc.

Unit 12
Monitoring of Chemical Contaminants: Heavy metal quantification by Atomic Absorption Spectrophotometer; Quantification of Agrochemicals by HPLC; Spectrofluorimetric determination of mycotoxins; Detection and quantification of Drug Residues.

Unit 13
Colour Characterization: Colour and appearance (gloss and translucence) monitoring through visual colorimeter, tri-stimulus colorimeters and reflectance spectrophotometer, CIE, Hunter-Lab, Munsel and other systems of three-dimensional expression of colour; Colour-based Sorting of foods; Computer Vision – Principles, applications and Benefits.

Unit 14
Objective Assessment of Subjective food-quality characteristics - Pitfalls and Promises.

Suggested Readings


DT-722 RESEARCH & DEVELOPMENT MANAGEMENT IN DAIRY INDUSTRY (3+0)

Objective
To provide in-depth knowledge to research scholar in selection and management of research project in the area of new product development and in patenting and transfer of technology processes.
**Theory**

**Unit 1**
Current Status of R&D Efforts in Dairy Processing in India and abroad.

**Unit 2**
Resource Management: Management of financial and human resources in diary industry: a) Structure and design of Research and Development organization; b) Analysis of organization behaviour – Transactional analysis; and c) Personnel management – Typology analysis, individual and the organization, team building, human behaviour at work, motivation.

**Unit 3**

**Unit 4**
Patenting Laws; Indian Patenting Act/International Protocols for technology transfer; Transfer of technology from Lab to Plant, HACCP, GMP/GHP practices in dairy processing. ISO14001, Total Quality Management (TQM), Six-Sigma concept.

**Unit 5**
Project proposal writing for research funding, Development of feasibility and technical report for dairy plant establishment, evaluation and report writing of projects.

**Suggested Readings**
4. IPR Bulletins (TIFAC) (www.tifac.org.in)

**List of Journals**
1. American Journal of Clinical Nutrition
3. Bioprocess and Biosystems Engineering
4. Comprehensive Reviews in Food Science and Food Safety
5. CRC Critical Reviews in Food Science and Nutrition
6. Food Engineering
7. Food Research International
8. Food Science & Technology (LWT)
10. Food Technology
11. Indian Dairyman
12. Indian Food Packer
13. Indian Journal of Dairy Science
15. International Journal of Dairy Technology
16. International Journal of Food Properties
17. International Journal of Food Science and Technology
18. Journal of American Oil Chemists’ Society
20. Journal of Biotechnology
21. Journal of Chemical Technology and Biotechnology
22. Journal of Dairy Research
23. Journal of Dairy Science
24. Journal of Food Biotechnology
25. Journal of Food Engineering
26. Journal of Food Processing and Preservation
27. Journal of Food Protection
28. Journal of Food Science
29. Journal of Food Science and Biotechnology
30. Journal of Food Science and Technology
31. Journal of Food Technology
32. Journal of Human Nutrition and Dietetics
33. Journal of Lipid Research
34. Journal of Texture Studies
35. Packaging Abstracts
36. Packaging India
37. Trends in Food Science and Technology

**Broad Topics of Research**

1. Application of UF retentates in value added products and health foods.
2. Application of reverse osmosis in dairy industry.
3. Application of microfiltration in dairy industry.
5. Application of modified microorganisms in the manufacture of improved quality dairy products.
7. Characteristics of newly developed microbial rennet in relation to curd forming behavior of ripened and unripened cheeses.
9. Development of kinetic data on physicochemical changes in different dairy/food products during processing and storage.
12. Development of newer variety of cheeses from microbial/recombinant rennet using cow and buffalo milk systems.
15. Development of casein/ whey protein hydrolysates with enhanced functionality for food application.
17. Development of indigenous detergents for cleaning and sanitization of membranes.
18. Development of mechanized systems for the production of heat desiccated milk sweets/desserts, such as rabri, basundi, kheer/payasam, kalakand, milk cake, etc.
20. Effects of processing variables on the textural properties of certain indigenous milk products.
23. Effects of ultrasonic treatment of milk products on their properties and microbial inactivation.
24. Effect of bactofugation keeping quality of milk under Indian conditions.
25. Extension of shelf life of dairy products by applying Hurdle Technology.
26. Effect of season on the compositional profile and physicochemical properties of milk-fat.
27. Flavour characteristics of fats from cows, buffaloes, goats and sheep.
28. Foaming properties of milk as influenced by its constituents
30. Investigation on quality improvement of dairy foods using novel ingredients.
31. Incorporation of fruits for value addition and improvement of nutritional value of traditional milk products.
32. Incorporation of cereals for value addition and improvement of nutritional value of traditional milk products.
33. Infra-red heating behaviour of milk and milk products.
34. Investigation of prebiotic potential of milk molecules and their utilization in development of synbiotic foods
35. Isolation and purification of natural antibacterial substances of milk for preservation of milk products
36. Low-temperature irradiation of dairy products.
37. Process modification of manufacture and storage of ghee to improve granulation and flavour of ghee.
40. Process development for herbal dairy products
41. Physicochemical properties of buffalo, goat and sheep milk-fats.
42. Rheological and textural characterization of certain traditional dairy foods.
43. Relationship between instrumental measurements of dairy/food product characteristics and their sensory assessment.
44. Shelf life extension of traditional milk sweets through use of bio preservatives.
45. Structure-texture relationships in selected dairy products.
46. Studies on extrusion cooking of high protein foods.
47. Studies on UHT processing of concentrated milk.
49. Studies on process development for health foods utilizing milk/milk by-products
50. Studies on development of low calorie dairy foods
51. Study of moisture sorption isotherms of traditional dairy products and milk sweets
52. Study of functional properties of UF retentates.
53. Study of fouling behaviour during UHT processing of buffalo milk.
54. Technology development for manufacture of specialty foods for aged/sports/diseased persons
55. Technology for development of milk-cereal fermented foods
56. Technology for production of bioactive milk components and their application in functional foods
57. Use of antimicrobial packaging material for shelf life extension of traditional and value added dairy products
58. Utilization of dairy by-products in formulated foods
60. Viscoelastic behaviour of buffalo-milk cheeses and other semi-solid products
61. Viscometric characterization of flowable buffalo-milk products.