Course Title with Credit Load
M.Tech. in Dairy Technology

Course Code	Course Title	Credit Hours
	Major Courses	
DT-511*	Advances in Dairy Processing	3+1
DT-512	Advances in Food Processing	3+1
DT-513*	Rheology of Dairy and Food Products	2+1
DT-514	Biotechnology for Dairy Applications	2+1
DT-515	Advances in Traditional Indian Dairy Products	2+1
DT-516	Non-conventional Processes for Dairy and Food Industry	2+1
DT-521*	Membrane Processing for Dairy Applications	2+1
DT-522*	Advances in Dairy and Food Packaging	2+1
DT-523	Technology of Food Emulsions, Foams and Gels	2+1
DT-524	Functional Foods and Nutraceuticals	3+1
DT-525	Production and Applications of Dairy Ingredients	2+1
DT-526	Advances in Cheese Technology	2+1
DT-591	Master's Seminar	1+0
DT-599	Master's Research	0+30

Course Contents
M. Tech. in Dairy Technology

I. Course Title : Advances in Dairy Processing

II. Course Code : DT 511

III. Credit Hours : 3+1

IV. Why this course?

The basic principles of dairy processing have been understood at undergraduate level. Any dairy plant has to be abreast with the latest developments taking place in the arena of dairy processing, dairy product preservation, quality assurance and public health safety, automation, mechanization, etc. Knowledge of such aspects will help in controlling milk solids losses, aid in process optimization and help in catering to quality dairy products to the consumers.

V. Aim of the course

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

VI. Theory

Unit I

Use of bio-protective factors for preservation of raw milk: effects on physico-chemical, micro-bial and nutritional properties of milk and milk products; Present status of preservation of raw milk.

Unit II

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; Nutritional aspects of UHT treated milk vis-à-vis retort sterilized/ HTST treated milk.

Unit III

Principles and equipment for bactofugation and bactotherm processes; Partial homogenization and its application in dairy industry, Low pressure homogenization; Microfluidization of milk: Principle, equipment, effects and applications.

Unit IV

Concentration processes and their impact on quality of finished products; Dehydration: advances in drying of milk and milk products; Freeze dehydration: physico-chemical changes and in-dustrial developments; Glass Transition Temperature and its relevance to dried milks.

Unit V

Water activity; Sorption behaviour of foods, energy of binding water, control of water activity of different milk products in relation to their chemical, microbiologi-cal 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 VI

Current trends in cleaning and sanitization of dairy equipment; 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, Water conservation methods.

VII. Practical

- Measurement of thiocyanate in milk system
- LP system for extending the keeping quality of raw milk
- Determination of HCT-pH profile of milk
- Determination of water activity and sorption isotherms of milk products
- Determination of WPNI of milk powders
- Functional properties of milk powders
- Determination of HMF content in dried milks
- Freeze drying of milk and milk products
- Homogenization efficiency
- Cleaning and sanitization efficiency of dairy equipment
- Visit to a UHT Processing plant.

VIII. Teaching Methods/Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review
- Student presentation
- Group Work and Group Discussion
- Visit to various dairy plants

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge to ensure delivery of safe and quality product from the dairy plant to the consumers
- To process the milk and dairy products in such a manner that losses of milk solids are minimal
- Be able to suggest to the dairy plant personnel, the latest type of tools that can be harnessed to produce quality products, without impairing the nutritive value of milk
- To suggest the dairy industry personnel regarding the formulation of detergent and/or acid and sanitizers which would help in efficient cleaning and sanitization of dairy equipment?

X. Suggested Reading

- Barbosa-CA, GV, Fontana Jr, AJ, Schmidt SJ, and Labuza TP. (Eds.). 2008. *Water Activity in Foods: Fundamentals and Applications* (Vol. 13). John Wiley and Sons.
- Britz T and Robinson RK. (Eds.). 2008. *Advanced Dairy Science and Technology*. John Wiley and Sons.
- Chandan RC and Kilara A. 2015. Dairy-based Ingredients. In: *Dairy Processing and Quality Assurance.* (2nd Edn.). Wiley-Blackwell.

- Chandan RC, Kilara A and Shah NP. (Eds.). 2015. *Dairy Processing and quality Assurance*. 2nd Edn, Wiley-Blackwell, pp. 1-696.
- Dekker M. *Benefits and potential risks of the lacto-peroxide system of raw milk preservation*. www.fao.org/docrep/fao/009/a0729e/a0729e00.htm
- Figura L and Teixeira AA. 2007. *Food physics: Physical properties-measurement and applications*. Springer Science and Business Media.
- Goyal MR, Kumar A and Gupta AK. (Eds.). 2018. *Novel Dairy Processing Technologies: Techniques, Management, and Energy Conservation*. CRC Press.
- Heldman DR. 2011. *Food preservation process design*. Academic Press.
- Hotchkiss JH, Werner BG and Lee EY. 2006. Addition of carbon dioxide to dairy products to improve quality: a comprehensive review. *Comprehensive Reviews in Food Science and Food Safety*, **5**(4), 158-168.
- Koca N. (Ed.). 2018. *Technological Approaches for Novel Applications in Dairy Processing*. InTechOpen.
- Leistner L and Gould GW. 2002. The hurdle concept. In:*Hurdle Technolo*gies, pp. 17-28, Boston, MA: Springer.
- Lewis MJ, Heppell N and Hastings A. 2000. *Continuous thermal processing of foods-Pasteurization and UHT Sterilization*. Aspen Publishers Inc.
- Nicoli MC. 2016. *Shelf life assessment of food*. CRC Press.
- Rahman MS. 2015. Hurdle technology in food preservation. In *Minimally processed foods*, pp. 17-33. Springer, Cham.
- Subramaniam P and Wareing P. (Eds.). 2016. *The stability and shelf life of food*. Woodhead Publishing.
- TetraPak Dairy Processing Handbook. 2015. www.dairypeocessinghandbook.com
- Thompkinson DK and Sabikhi L. 2012. *Quality milk production and processing technology*. New India Publishing Agency.

Websites

- GEA Dairy Processing Industry-https://gea.com/en/applications/dairy-processing/index.jsp
- IndiaDairy.com-https://indiaDairy.com
- Scherjon Dairy Equipment Holland: Dairy processing equipment-https://scherjon.eu/
- National Dairy Council-https:/nationaldairycouncil.org/
- Alfa Laval – Dairy Processing-https://alfalaval.in/industries/food-dairy-and-beverage/dairy-processing/

I. Course Title : Advances in Food Processing

II. Course Code : DT 512

III. Credit Hours : 3+1

IV. Why this course?

The basic principles of food processing, including dairy processing has been understood at undergraduate level. Any food plant has to be abreast with the latest developments taking place in the sphere of food processing, food product preservation, quality assurance and public health safety, automation, mechanization, etc. Information on composite foods may give an idea about foods formed using amalgamation of dairy foods with other food materials and ingredients. Knowledge of such aspects will help in developing value-added food products, cater to functional (health promoting) foods, adopting non-thermal processing methods to obtain food products having freshness and preserved nutrients and colour, etc.

V. Aim of the course

To provide in-depth understanding of advances in theoretical and practical aspects of food processing keeping in mind the nutritive value of product and its perishability

VI. Theory

Unit I

Status of food processing industry in India and abroad; Prospects and constraints in development of Indian food industry.

Unit II

Development in Post-harvest management of Fruits and Vegetables (Controlled and Modified Atmospheric Storage, Designing aspects of CAS/MAS, Components of CAS/MAS), hypobaric storage, harvesting indices for fruits and vegetables.

Unit III

Newer methods of drying of foods (Super-heated steam drying, Freeze drying, infra-red drying and microwave drying; Osmodrying process), Concepts of UHT and retort sterilization of food products, packaging materials for thermally processed foods.

Unit IV

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 V

Advances in milling of rice (solvent extractive milling) and Turbo milling of wheat. Emerging concepts in cereal processing including gluten free products, Low calories bakery products, Technologies for breakfast cereals, Utilization and importance of dairy ingredients in bakery products.

Unit VI

Definition, classification and technologies of fabricated and formulated foods and their nutritional aspects. Imitation dairy products and dairy analogues; meat 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. Fortification of staples.

Unit VII

Non-thermal processing technologies for food: Principles, Effect on food constituents and Salient application in food sector/industry.

Unit VIII

Enzymes in food processing; newer concepts in food processing including organic foods; Processing of organic raw material; Genetically modified foods; Space foods, Nutrigenomics, metabolomics and other Omics concepts in food processing.

VII. Practical

- Experiments on MAS of fruits and vegetables
- Application of microwave for blanching and drying of foods
- Osmoair drying of fruits and vegetables

- Retort processing of food products
- Application of milk ingredients in caramel, egg-less cake, mayonnaise
- Enzymatic extraction and clarification of fruit juices
- Preparation of soymilk and tofu, Manufacture of sauerkraut/ fermented vegetables
- Preparation of protein isolates
- Application of extrusion processing for breakfast cereal and meat analogue manufacture
- Application of hydrocolloids in stabilization of proteins in acidified beverages
- Manufacture of low calorie and gluten-free cereal products.

VIII. Teaching Methods/Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review
- Student presentation
- Group Work and Group Discussion
- Visit to various food plants

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on the latest post-harvest management of fresh produce with limited shelf life
- To have an idea about the processing methods that do not diminish the quality attributes of food being processed
- To know about the recent packaging methodologies that can enhance the shelf life of fresh as well as processed produce/food.
- To have any idea about the enzymes that can be used as processing aids.

X. Suggested Reading

- Corredig M. 2009. *Dairy Derived ingredients: Foods and Nutraceutical Uses*. Washington DC: CRC press.
- Eskin Michael NA and Shahidi F. 2013. *Biochemistry of Foods*. 3rd Edn, Elsevier Publication.
- Fellows PJ. 2000. *Food Processing Technology: Principles and Practi*ces. 2nd Edn, CRC Press, London: Woodhead Publishing Ltd.
- Fennema CR. 1975. *Principles of Food Science*. Part-II: Physical principles of Food preservation. New York: Marcel Dekker.
- Guy R. 2001. *Extrusion cooking: Technologies and Applications*. England: CRC-Woodhead Publishing Ltd.
- Honseney RC. 1986. *Cereal Science and Technology*. American Association of Cereal Chemists, Minnesota.
- Hui YH, Meunix-Goddick L, Hansen AS, Josephsen J, Nip W-K, Stanfield PS and Toldra F. 2004. *Handbook of Food and Beverage Fermentatio*n. New York: Marcel Decker.
- Hui YH, Nip WK, Rogers RW and Young DA. 2001. *Meat Science and Application*. New York: Marcel Decker.
- Muthukumarappan K and Knoerzer K. 2020. *Innovations in Food Processing Technologies: A comprehensive review*, 1st ed., Elsevier.
- Penfield MP, and Campbell AM. 1990. *Experimental Food Science*. 3rdEdn. New York: Academic Press.
- Ramaswamy H and Marcotte M. 2006. *Food Processing: Principles and Applications*. USA: Taylor and Francis Group.
- Wrigley CW and Batey IL. 2010. *Cereal Grains: Assessing and Managing Quality*. Washington DC: CRC Press.

Websites

- Ministry of Food Processing Industry-https://india.gov.in/official-website-ministry-food-processing-industries-0
- Indian Food Industry, Food Processing Industry in India, Statistics-https://ibef.org › Industry
- *Food Processing – Make in India*-https://makeinindia.com/sector/food-processing
- *Welcome to APEDA*-https//*apeda.gov.in/*
- *Food safety and quality: Chemical risks and JECFA-FAO-https/ /fao.org/food/food-safety-quality/scientific-advice/jecfa/en/*
- HACCP and GHP: Standards in Food Industry: (EUFIC)-https://eufic.org/en/food-safety/article/food-industry-standards-focus-on-haccp

I. Course Title : Rheology of Dairy and Food Products

II. Course Code : DT 513

III. Credit Hours : 2+1

IV. Why this course?

The mouth feel of processed food product is one of the parameters for the acceptance of foods. The sensory textural quality of food is closely related to the rheology of that pertinent food product. Any technological treatment meted out to dairy/food product leads to change in its rheological characteristics. Such treatment can be specifically practiced to improve the textural quality of food product. Rheology can be used as a quality control tool to monitor the quality of food product being processed or manufactured.

V. Aim of the course

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

VI. Theory

Unit I

Introduction to rheology of foods: Definition of texture, rheology and psychophysics – their structural basis; Physical considerations in study of foods; Salient definitions of stress tensor and different kinds of stresses.

Unit II

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

Unit III

Viscometers; Types (Co-axial cylinders, Spindle or Impeller type, Cone-plate, Capillary, Falling sphere, Vibratory, Extrusion, and Orifice), comparative assessment, merits and limitations; Rheometer: principles and operational features.

Unit IV

Rheological characterization of semi-solid and solid foods; Mechanical models for viscoelastic foods (Maxwell, Kelvin, Burgers and generalized models) and their application; Dynamic measurement of viscoelasticity.

Unit V

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 VI

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; Microstructure of dairy products; Tribology and its applications.

VII. Practical

- Study of different types of viscometers.
- Flow behaviour of fluid dairy products.
- Thixotropy in ice-cream mix.
- Force-deformation study in selected dairy products using Texture Analyzer.
- Effect of test conditions on the texture profile parameters of dairy products.
- Stress relaxation studies in solid foods.
- Use of Cone Pen-etrometer and FIRA-NIRD extruder for measurement of butter texture.
- Assessment of pasting profile of starch/flours using viscoanalysers.
- Oscillatory measurements using Rheometer.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

– Classify food products based on their rheological characteristics
– Understand the relationship between instrumental rheology and sensory perception of food
– To recommend use of textural analysis of dairy and food product for its quality control aspect
– To recommend specific type of instrument for textural analysis of specific type of food (fluid or solid)

IX. Suggested Reading

- Ahmed J, Ptaszek P and Basu S. (Eds.). 2016. *Advances in Food Rheology and its Applications*. Amsterdam: Woodhead Publishing.
- Barnes HA, Hutton JF and Walters K. 1989. *An introduction to rheology*. Elsevier Pub.
- Bourne M 2002. *Food texture and viscosity: Concept and Measurement*. London: Elsevier Pub.
- Irgens F. 2014. *Rheology and Non-Newtonian Fluids*. New York: Springer International Publishing.
- Malkin AY and Isayev AI. 2017. *Rheology: Concepts, methods, and applications*. Toronto: ChemTec Publishing.
- Mezger TG. 2006. *The Rheology Handbook: For Users of Rotational and Oscillatory Rheometers*. Hannover: Vincentz Network GmbH and Co KG.
- Mohsenin NN. 1970. Physical properties of plant and animal materials. Vol. 1. Structure, physical characteristics and mechanical properties. New York: Gordon and Breach Science Publishers.
- Norton IT, Spyropoulos F and Cox P. (Eds.). 2010. *Practical Food Rheology: An Interpretive Approach*. John Wiley and Sons.

- Rao MA. 2013. *Rheology of fluid, semisolid and solid foods: Principles and applications*. New York: Springer Science and Business Media.
- Sherman P. 1979. *Food texture and rheology*. London: Academic press.

Websites

- Texture in Food Production – Food Technology Corporation- https://www.foodtechcorp.com/texture-food-production
- Universal testing/Tensile testing machine: SCHIMADZU- https//shimadzu.com/an/test/universal/index.html
- Texture Analysis System and Software – Food Online- https://foodonline.com/doc/texture-analysis-system-and-software-0001

I. Course Title : Biotechnology for Dairy Applications

II. Course Code : DT-514

III. Credit Hours : 2+1

IV. Why this course?

Biotechnology is a tool for the value addition to dairy foods. Genetic techniques have been employed to manipulate bacteria that have significance to the dairy industry. Biotechnological means can be used to regulate the production of flavour enhancing metabolites and to develop starter cultures that are resistant to bacteriophage and bacteriocins. Genetic engineering will be able to deliver dairy foods that can be tolerated by lactose intolerant persons or for persons who are allergic to milk proteins too.

V. Aim of the course

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

VI. Theory

Unit I

Introduction to process biotechnology; Principles of recombinant DNA technique; Development and impact of biotechnology on dairy and food industry.

Unit II

Microbial rennet and recombinant chymosin - characteristics and applications in cheese making; exogenous free and microencapsulated enzymes. Immobilized enzymes - their application in continuous coagulation of milk in cheese making; Enzyme modified cheeses (EMC) - their utilization in various food formulations.

Unit III

Technological requirements of modified micro-organisms for applications in cheese, Probiotic and fermented milk products; physiologically active bio-peptides/ nutraceuticals.

Unit IV

Protein hydrolysates - production, physico-chemical, therapeutic properties and application in food formulations; Enzymatic hydrolysis of lactose for preparation of whey and UF-permeate beverages; Continuous lactose hydrolysis of whey.

Unit V

Microbial polysaccharides - their properties and applications in foods; Production of alcoholic beverages; Bio-sweeteners - Types, properties and their applications in dairy and food industry.

Unit VI

Bio-preservatives - characteristics and their applications in enhancing the shelf life of dairy and food products.

VII. Practical

- Effect of exogenous enzymes on hydrolysis of protein and fat in culture containing milk sys-tems
- Factors affecting the coagulation of milk by microbial and vegetable rennets
- Manu-facture and evaluation of probiotic cheese and fermented milks
- Preparation of Enzyme Modified Cheese
- Determination of glycolysis, proteolysis and lipolysis in cheese and fermented milks
- Enzymatic process for manufacture of low lactose milk/whey products
- Preparation of casein hydrolysates
- Visit to a bio-processing unit.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

– To have any idea about the enzymes that can be used as processing aids.
– Have knowledge on the latest biotechnological approaches to add value to the dairy product
– Ability to produce protein hydrolysates
– Application of biotechnology for bio-preservation of dairy foods

IX. Suggested Reading

- Aluko RE. (Ed.). 2012. *Functional Foods and Nutraceuticals*. Springer.
- Bhat R, Alias AK and Paliyath G. 2012. *Progress in Food Preservation*. John Wiley and Sons Ltd. (Print ISBN: 9780470655856. Online ISBN: 9781119962045) DOI: 10.1002/9781119962045.
- Coffey AG, Daly C and Fitzgerald G. 1994. The impact of biotechnology on the dairy industry. Biotechnology Advances, 12(4): 625-633. Elsevier Pub. doi.org/10.1016/0734-9750(94)90003-5

I. Course Title : Advances in Traditional Indian Dairy Products

II. Course Code : DT 515

III. Credit Hours : 2+1

IV. Why this course?

Traditional Indian dairy products (TIDP) especially the sweetmeats have its own significance in Indian diet and have tremendous export potential. The application of strict hygiene in manufacture of such TIDPs is the need of the day and its technology up gradation (especially mechanization and automation) from research level to industry level needs to be harnessed. Even there is an urgent need to have knowledge about the 'Techno-economic aspects for establishing commercial units for traditional dairy products'. Enhancement in the shelf life of TIDPs has been still a challenging task in the dairy industry.

V. Aim of the course

To project the present status, modernization and globalization of production of traditional Indian dairy products with a focus on process innovation, shelf life, quality and functionality enhancement.

VI. Theory

Unit I

Global prospects and export potential of traditional Indian dairy products.

Unit II

Differences in quality of traditional dairy products from cow, buffalo, goat, camel, and sheep milks; Process innovations in commercial production of heat-desiccated, coagulated and fermented traditional dairy products; Mechanized production of traditional milk based sweets; Automation for manufacture of ghee, *paneer*, *dahi*, *lassi*and traditional sweetmeats.

Unit III

Composite traditional milk products; Application of membrane technology and microwave processing for industrial production of traditional Indian dairy products.

Unit IV

Technologies for region specific traditional Indian dairy products and their value addition, their application as a vehicle for delivering functional ingredients; Manufacture of dietetic traditional dairy products.

Unit V

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

Unit VI

Convenience traditional dairy products; Food safety issues; Shelf life extension of food using newer techniques; Novel packaging and preservatives.

VII. Practical

- Production of reduced calorie, composite and functional traditional Indian dairy products.
- Microwave heating of traditional Indigenous milk delicacies for shelf life extension.
- Membrane technology for improving the quality of traditional Indigenous products made from cow and buffalo milk.
- Preparation of feasibility report for establishing commercial units for traditional dairy products.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Have an idea about the global prosper and export potential of TIDPs.
- Be an entrepreneur in delivering mechanized production of certain TIDPs including automation, wherever feasible.
- Be able to recommend the methods to enhance the shelf life of perishable TIDPs and recommend the type of packaging technology to be used for safety and shelf life extension.

IX. Suggested Reading

- Aneja RP, Mathur BN, Chandan RC and Banerjee AK. 2002. *Technology of Indian dairy products*. A Dairy India Publication.

- Goyal MR, Kumar A and Gupta AK. 2018. *Novel Dairy Processing Technologies: Techniques, Management, and Energy Conservation*. CRC Press.
- Puniya AK. 2015. *Fermented Milk and Dairy Products;* CRC Press/Taylor and Francis (ISBN 9781466577978)
- Shrott C and O'Brien. 2003. *Handbook of Functional Dairy Products*. CRC Press
- *TetraPak Dairy Processing Handbook*. 2015. www.dairypeocessinghandbook.com.

Websites

- Indian Dairy Product Market–Indian Council of Food and Agriculture– https//icfa.org.in/assets/doc/reports/Indian_Dairy_Product_Market.pdf
- Mechanized production of Indian Dairy Products–AMEFT– https//download.ameft.com/MechanisedProduction.pdf
- Indian Dairy Industry–Aavin – https//aavinmilk.com/dairyprofile.html
- Present Status of Traditional Dairy Products–Technische–TIB– https://www.tib.eu/en/search/id/./Present-Status-of-Traditional-Dairy-Products/

I. Course Title : Non-Conventional Processes for Dairy and Food Industry

II. Course Code : DT 516

III. Credit Hours : 2+1

IV. Why this course?

Unravelling the truths based on the knowledge of 'science and technology' has paved the way for development of several non-conventional technologies. These when used judiciously can have advantage in minimizing the changes in the colour, nutritive value and textural quality of dairy and food products. Certain non-conventional processes may be used as adjunct to the conventional processing technology to reap the benefits from use of such synergistic effects.

V. Aim of the course

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

VI. Theory

Unit I

Irradiation: sources and properties of ionizing radiation; Mechanism of interaction with microorganisms and food components; Chemi-cal effects; Industrial irradiation systems, benefits and limitations; UV pasteurization of milk; Safety aspects in radiation processing; National and international regulations in relation to radiation processing; Cold plasma processing.

Unit II

High frequency heating (Microwave and Radio frequency processing): Principles, merits and demerits; Design and working of processing units; Applications in dairy and food processing; Microwavable packaging; Safety aspects.

Unit III

Infra-red (IR) heating and Ohmic heating: Principle, equipment and applications.

Unit IV

Ultrasonic treatment of food: Mechanism of ultrasound induced cell damage,

generation of ultrasound, design of power ultrasonic system, types of ultrasonic reactors, application of power ultrasound in food processing, effects on food constituents, ultrasound in amalgamation with other food processing operations – thermo-sonication, manosonication, thermo-manosonication, advantages and future prospects.

Unit V

High hydrostatic pressure (HHP) processing: Principle of microbial inactivation, barotolerance of microorganisms, effect on food constitu-ents; equipment; dairy and food applications; Merits and demerits of HHP.

Unit VI

Pulsed electric field processing; Description/ mechanism and factors affecting microbial inactivation; effects on food com-ponents; Present status and future scope for food applications.

Unit VII

Super-critical Fluid Extraction; Principle, instrumentation and applications.

VII. Practical

- Market survey of food products processed using non-conventional technologies
- Pasteurization and concentration of milk using ohmic heating
- Degassing of fluids using ultrasound
- Determination of power output and temperature profile of a microwave oven
- Effect of chemical composition on heating behaviour of milk and milk products
- Microwave pasteurization of milk
- Effect of shape and size of container on microwave heating
- Preparation of 'instant' products in a microwave oven
- Visit to a commercial food processing facility.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To recommend use of feasible non-conventional technology for processing and shelf life extension of food
- Application of non-conventional processing technology as adjunct processing for accomplishing hurdle technology for dairy and food products
- To visualize the difference in the physico-chemical properties and microbial changes in dairy/food product when adopting traditional vs. non-conventional technology

IX. Suggested Reading

- Chen D, Sharma SK and Mudhoo A. 2012. *Handbook on applications of ultrasound-sonochemistry for sustainability*. Boca Raton: Taylor and Francis Group, LLC, 273-739.
- Delgado A, Kulisiewicz L, Rauh C and Wiersche A. 2012. *Novel thermal and non-thermal technologies for fluid foods*. New York: Academic Press.
- Monika Willert-Porada. 2001. Advances in Microwave and Radio Frequency Processing. Report from the 8th International Conference on 'Microwave and high frequency heating' held in Bayreuth, Germany, 2001.
- Nanda V and Sharma S. 2017. *Novel food processing technologies*. New India Publishing Agency, New Delhi, India.
- Raso J and Heinz V. 2006. *Pulsed electric fields technology for the food industry fundamentals and applications*. Springer Science + Business Media, LLC, USA.

• Zhang HQ, Barbosa-Canovas GV, Balasubramaniam VM, Dunne CP, Farkas DF and Yuan JT. (Eds.). 2011. *Non-thermal processing technologies for food* (Vol. 45). John Wiley and Sons.

Websites

- Microwave-assisted green extraction technology for sustainable food processing-https://intechopen.com/books/emerging-microwave-technologies-in-industrial-agricultural-medical-and-food-processing/microwave-assisted-green-extraction-technology-for-sustainable-food-processing
- Ultrasound in the food industry– https://hielscher.com/food_01.htm; Microwave assisted extraction (MAE)-https://slideshare.net/Nabiilah/microwave-assisted-extraction

I. Course Title : Membrane Processing for Dairy Applications

II. Course Code : DT 521

III. Credit Hours : 2+1

IV. Why this course?

Amongst non-thermal processes for dairy applications, membrane processing is one of the significant illustrations. Membrane processing has helped the dairy industry, not only to obtain dairy ingredients with high protein and low lactose content, but even to recover the important whey proteins from the by-product – whey. Salient application of use of membrane processed milk concentrate is in cheese making and in concentrated and dried milk manufacture.

V. Aim of the course

To elucidate the basics of membrane technology and its applications in dairy processing

VI. Theory

Unit I

Membrane techniques; Classification and characteristics of filtration pro-cesses; types of commercially available membranes; membrane hardware, design of membrane plants, modelling of ultrafiltration (UF) processes, mass transfer model, resistance model; Membrane fouling-problems and mitigation strategies; Cleaning and sanitization of different types of membranes.

Unit II

Factors affecting permeate flux during ultrafiltration and reverse osmo-sis of milk and sweet/sour whey, energy requirements for membrane processing of milk and whey.

Unit III

Applications of ultrafiltration (UF), reverse osmosis, nanofiltration and microfiltration in the dairy industry: food and pharmaceutical grade lactose, low lactose milk powder, dairy whiteners, WPC, WPI, MPC, MPI, Native micellar casein powder, etc. Preparation, properties and uses of Milk Protein Concentrate (MPC) and Milk Protein Isolate (MPI); Manufacture of some cheeses and fermented milk products and impact of membrane processing on quality of such products. Use of membrane processing techniques for separating prophylactic biological from milk.

Unit IV

Demineralization: principles, processes, equipment and applications.

Unit V

Functional properties of whey proteins (WPC and WPI), micellar casein and UF milk retentate and their modifications.

VII. Practical

- Factors affecting permeate flux during membrane processing (type of feed, temperature, transmembrane pressure, etc.)
- Effect of microfiltration of skim milk and whey on fat content and microbial count
- Preparation of WPC, WPI, MPC, native micellar casein, etc.
- Evaluating the functional properties of milk proteins.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

– To recommend use of membrane processed milk in manufacture of selected dairy products
– Application of specific membrane processes for milk/whey to prepare certain prophylactic biological
– To recommend the suitable cleaning and sanitization agents to take care of cleaning and sanitization of specific type of membrane used in membrane processing of milk.

IX. Suggested Reading

- Baker RW. (Ed.) 2012. *Membrane Technology and Applications*, 3rd Edn,Wiley Publishers.
- Cooper A.R. (Ed.) 2013. *Ultrafiltration Membranes and Applications* (Vol. 13). Springer Science and Business Media.
- Field RW, Bekassy-Molnar E, Lipnizki F and Vatai G. 2017. *Engineering Aspects of Membrane Separation and Application in Food Processing*. CRC Press.
- Fuquay JW, Fox PF and Mc Sweeney PL. 2011. *Encyclopedia of Dairy Sciences*. Academic Press.
- Hu K and Dickson J. (Eds.). 2015. *Membrane Processing for Dairy Ingredient Separation*. John Wiley and Sons.
- Mohanty K and Purkait M. 2011. *Membrane Technologies and Applications*. CRC Press, Taylor and Francis Group.
- Tamime AY. (Ed.). 2013. *Membrane processing: Dairy and beverage applications*. Wiley-Blackwell Publishers, pp. 1-370.

Websites

- Membrane technology in Dairy Industry – Slideshare-https://slideshare.net/./membrane-technology-in-dairy-industry
- Specialty and Dairy – Products – Toray Membrane-https://toraywater.com/products/specialty/index.html
- Membrane filtration in the dairy industry GEA-https://gea.com/en/binaries/gea-membrane-filtration-brochure-for-dairy-industry_tcm11-17109.pdf

I. Course Title : Advances in Dairy and Food Packaging

II. Course Code : DT 522

III. Credit Hours : 2+1

IV. Why this course?

Packaging of food though carried out towards the end of product manufacture has a great role to play in conserving the processed food in its original state – including freshness of fresh food. Packaging plays a crucial role in acceptance of the food

product by the consumer and the extensibility of the shelf life of the food being packaged, especially using advanced techniques such as MAP, active packaging, etc.

V. Aim of the course

To impart basic and advanced knowledge of dairy and food packaging

VI. Theory

Unit I

Trends in packaging industry; designing framework for packaging; Testing of packaging materials.

Unit II

Adhesives; Graphics; Coding (Barcode and Quick Response code), and labeling used in food packaging.

Unit III

Protective packaging of foods; Effect of light, oxygen and moisture on packaged food.

Unit IV

Packaging of dairy products, convenience foods, fresh produce and fruits and vegetable products, Packaging of fats and oils, spices, meat, poultry, fish and other sea foods.

Unit V

Modified atmosphere packaging, Shrink and stretch packaging; Self-heating and self-cooling cans.

Unit VI

Retort pouch technology, microwavable, biodegradable, and edible packages; Principles and applications of Active Packaging, Smart and Intelligent Packaging, Antimicrobial packaging.

Unit VII

Industrial packaging: unitizing, palletizing, containerizing, distribution systems for packaged foods.

Unit VIII

Safety aspects of packaging materials; sources of toxic materials and migration of toxins into food materials, packaging and flavour interaction.

VII. Practical

- Testing of packaging materials for qual-ity assurance: thickness, GSM, grease resistance, bursting strength, tearing resistance, WVTR, puncture resistance
- Estimation and prediction of shelf life of packaged foods
- Development of edible, biodegradable and antimicrobial films
- MAP of perishable foods
- Effect of edible coatings on respiration behaviour of fruits and vegetables
- Application of oxygen scavengers in packaged foods.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

– To recommend the type of package suitable for specific type of dairy or other food products

– To employ intelligent packaging techniques in food packaging to warn the public in case of impeding health hazard
– Recommending SOPs to the food industry personnel to avoid migration of toxic substances from the package into the food system

IX. Suggested Reading

- Coles R, McDowell D and Kirwan MJ. 2003. *Food Packaging Technology*. Oxford: Oxford Blackwell. Frank, A., Paine, H., and Paine,Y. (1983). *A Handbook of Food Packaging*. Glasgow: Leonard Hill.
- Gordon LR. 2013. *Food Packaging: Principles and Practic*e, 3rd Edn., Florida, USA: CRC Press, Taylor and Francis Group.
- Han JH. 2005. *Innovations in Food Packaging*. Elsevier Science and Technology Books.
- Parry RT. 1993. *Principles and Applications of Modified Atmosphere Packaging of Foods*. Dordrecht: Springer Science+Business Media.
- Piergiovanni L and Limbo S. 2015. Food Packaging Materials. In: *Chemistry of Foods*, Springer Publishers.
- Raija A. 2006. *Novel Food Packaging*. England: Woodland Publishing Co.
- Robertson GL. (Ed.). 2012. *Food Packaging: Principles and Practice*. 3rd Edn.,Florida, US: CRC Press.
- Robertson GL. 2010. *Food Packaging and Shelf Life: A Practical Guide*. Boca Raton: CRC Press.
- Yam KL. 2009. *The Wiley Encyclopedia of Packaging Technology*, 3rd Edn., USA: John Wiley and Sons, Inc.

Websites

- Indian Institute of Packaging-https//iip-in.com/
- The Regulation of Food Packaging-https://www.packaginglaw.com/special-focus/regulation-food-packaging
- Packaging Industry Servies-www.nsf.org/services/by-industry/food-safety-quality/packaging

I. Course Title : Technology of Food Emulsions, Foams and Gels

II. Course Code : DT 523

III. Credit Hours : 2+1

IV. Why this course?

In order to improve the viscosity or rheological characteristics of food systems, certain food additives such as stabilizers, emulsifier and even foaming agents play a significant role. The chances of probability of defect in certain food products can be circumvented through use of such food additives. Emulsifiers play a great role in maintaining emulsion of two or multiple phases in the food system till its consumption. Foaming agents are of significance in ice cream, whipping cream, meringue, certain baked goods, etc.

V. Aim of the course

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

VI. Theory

Unit I

Food dispersions, their characteristics and factors affecting food dispersions.

Unit II

Food emulsions; Emulsifiers and their functions in foods; HLB concept for food

emulsifiers; Emulsion formation and stability; Surfactants.

Unit III

Dairy based foams and their applications, structure of foams; Egg foams and uses; Foam formation and stability.

Unit IV

Theory of gel formation; Carbohydrate and protein based gels. Gelled milk products. Advances in food gels (organogel, hydrogel and nanogel).

Unit V

Structure of dairy based emulsions, foams and gels; blend of stabilizers and emulsifiers; Effect of stabilizers and/or emulsifiers on functional properties of dairy foods; Aerosols and propelling agents in foamed dairy products.

Unit VI

Techniques for evaluating the structure of food emulsions, foams and gels

VII. Practical

- Determination of emulsifying efficiency and emulsion stability
- Examination of foaming capacity and foam stability
- Gel formation and gel properties
- Preparation of hydrogels and organogels
- Preparation of single and double emulsions.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

– To be able to recommend specific type of food additive from amongst stabilizers and emulsifiers for stability of the food system

– Be able to recommend solution to the food processor to improve upon the textural quality of food products through use of food additives like stabilizers and/or emulsifiers

– To make the food processors understand how the type of emulsion in question in the food product has a bearing on the functional property of that specific food product

IX. Suggested Reading

- Rajah KK. (Ed.). 2014. Emulsifiers and stabilisers. Chapter 7.Young, N.W.G. *Fats in food technology*.UK: John Wiley and Sons Ltd. (ISBN: 9781405195423).
- Valdez B. (Ed.) 2012. Milani J and Maleki G. Hydrocolloids in food industry. Chapter in Book. *Food industrial processes – Methods and equipment*. InTech Europe, Rijeka, Croatia, pp. 1-418 (www.InTechopen.com)
- Whitehurst RJ. (Ed.). 2004. *Emulsifiers in food technology*. 1st Edn. Wiley-Blackwell Publisher, pp. 1-264. (ISBN-13 978-1405118026).

X. Websites

- Stabilizers – Specialty food ingredients – Federation of European Specialty Food Ingredients Industry-https://specialtyfoodingredients.eu/ingredients-and-benefits/group/stabilizers
- Emulsifier Solutions – Corbion- https://corbion.com/base/DownloadHelper/DownloadFile/8386

I. Course Title : Functional Foods and Nutraceuticals

II. Course Code : DT 524

III. Credit Hours : 3+1

IV. Why this course?

Ingestion of food possessing nutraceuticals can sustain and maintain human health – free from diseases. Today's consumers are aware about the health promoting foods and if the industry launches functional foods, there are takers for such foods. Several herbs and spices are known to contain components that have nutraceutical value. Ayurveda system is built on such naturally available materials. However, consumer does want to seek food that can sustain their health and nutritional requirement – not to rely on medicines. Fermented probiotic foods are the latest prominent functional foods.

V. Aim of the course

To impart knowledge about functional ingredients and nutraceuticals and their utilization in developing physiologically beneficial health foods, functional foods and speciality foods

VI. Theory

Unit I

Classes of functional foods and their status.

Unit II

Functional ingredients; Classification; Dietary and therapeutic significance.

Unit III

Food fortification; Significance and techniques of fortifying foods with functional ingredients.

Unit IV

Infant nutrition; Dietary formulations, special needs, additives; Geriatric Foods: Design considerations, ingredients, special needs; Sports foods: Significance, strategies and design considerations.

Unit V

Reduced calorie foods: Significance, strategies, additives (fat replacers, bulking agents, non-nutritive sweeteners).

Unit VI

Low sodium and low lactose foods: Nutritional and health significance.

Unit VII

Herbs; Classification; Therapeutic potential, applications; Phytochemicals; Classes; Physiological role; Applications; Bioactive ingredients from animal and marine sources.

Unit VIII

Probiotic, prebiotic and synbiotic foods: Concept and applications.

VII. Practical

- Determination of soluble and insoluble fibre
- Determination of antioxidant activity of functional ingredient/food

- Determination *of in vitro* bioavailability of nutrients
- b-galactosidase activity for low-lactose dairy products
- Prebiotic potential of selected plant/milk components
- Probiotic potential of selected microorganisms
- Preparation of functional foods

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

– Be able to identify food in which fortification with necessary nutrients are required
– Be able to evolve Geriatric foods and food for infants based on their requirement and physiological functions
– To make food available to the consumers amalgamated with functional ingredients such as herbs, phytochemicals, etc.

IX. Selected Reading

- Earle M, Earle R and Anderson A. (Eds.). 2001. Food product development.1st Edn., Woodhead Publishing, pp. 1-392 (eBook ISBN: 9781855736399).
- Francesco C. (Ed.). 2017. Advances in dairy products. John Wiley and Sons Ltd. pp. 1-448. Chapter 4.2 - Consumer insight in the process of new dairy products development(ISBN: 9781118906460).
- Kanekanian A. (Ed.). 2014. Milk and dairy products as functional foods. John Wiley and Sons, Ltd., UK: West Sussex, pp. 1-373.
- Leong TSH, Manickam S, Martin GJ, Li W and Ashokkumar M. 2018. Ultrasonic Production of Nano-emulsions for Bioactive Delivery in Drug and Food Applications. Springer.
- Saarela M. (Ed.). 2007. Functional dairy products (2007) Vol. 2, Series in Food Science, Technology and Nutrition, Woodhead Pub., pp. 521-539.
- Shortt C and O'Brien J. (Eds.). 2003. Handbook of functional dairy products – Functional foods and Nutraceuticals, 1st Edn. Boca Raton, FL: CRC Press, pp. 1-312.

Websites

- Foods for Specified Health Uses (FOSHU)-https://mhlw.go.jp/english/topics/foodsafety/fhc/02.html
- A New Definition for Functional Food by FFC-https//functionalfoodscenter.net/files/111174880.pdf
- Food-info.net: Functional Foods-https//food-info.net/uk/ff/intro.htm

I. Course Title : Production and Applications of Dairy Ingredients

II. Course Code : DT 525

III. Credit Hours : 2+1

IV. Why this course?

Milk is a source of several components, which may contribute to nutrients, nutraceuticals, flavour, colour, texture to the food products in which they may be incorporated. Nowadays, we have perfected technologies to separate the dairy components having specified function for use in dairy as well as food products. The by-products such as whey and buttermilk can be salvaged through separation of components, which are of significance to the dairy and food industries alike.

V. Aim of the course

The aim of this course is to give comprehensive information of various milk components used as ingredients in food processing with regard to their separation, properties and applications.

VI. Theory

Unit I

An overview of dairy ingredients for food processing; Composition, nutritive value and health attributes of dairy ingredients; Important quality indices; National and international regulatory standards.

Unit II

Principles of conventional and novel approaches for separation, concentration and fractionation of milk components(Ig, lf, b-Lg): centrifugal separation, concentration, drying, membrane processing, enzyme-assisted separation, supercritical fluid extraction, electric field assisted membrane technique, etc.

Unit III

Chemical, physical and functional characteristics of concentrated and dried dairy ingredients (SMP, WMP, lactose, whey powder, WPC, WPI, MPC, casein and caseinates, cream powder, butter powder, cheese powder, yogurt powder, buttermilk powder, etc.).Miscellaneous dairy ingredients, viz. dairy permeates, hydrolysates, coprecipitates andlactoferrin.

Unit V

Interactions of dairy ingredients with other food components and its effect on product quality.

Unit V

Applications of dairy ingredients in food industry: bakery and confectionery; Infant, adult and sports nutrition; Processed meat products; spreads; functional Foods; edible films and coatings.

VII. Practical

- Manufacture of whey powder, caseinates, whey protein/milk protein concentrates, lactose, sweet cream butter milk powder, cream powder, yogurt powder and cheese powder.
- Determination of functional and nutraceutical properties of dried dairy ingredients.
- Manufacture of enzyme-modified dairy ingredients
- Production of eggless cakes using WPC
- Production of processed meat products incorporating caseinates
- Visit to a dairy ingredients manufacturing industry.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Be able to separate the various important components from milk/dairy byproduct having significance in dairy and food industries
- Be able to recommend the required type of specialized dairy ingredient for use in formulated and composite foods
- To be able to erect a dairy factory producing specialized dairy ingredients with immense value addition

IX. Suggested Reading

- Chandan RC and Kilara A. 2011. *Dairy Ingredients for Food Processing*. Iowa, USA: Blackwell Publishing Ltd.
- Corredig M. 2009. *Dairy Derived Ingredients: Food and Nutraceutical Uses*. Cambridge, UK: Woodhead Publishing Ltd.

- Fox PF. 1985. *Developments in Dairy Chemistry*. Vol.3.Lactose and minor constituents, New York: Elsevier Applied Science.
- Fox PF. 1989. *Developments in Dairy Chemistry*. Vol.4. Functional milk proteins, New York: Elsevier Applied Science.
- McSweeney PLH and Fox PF. 2013. *Advanced Dairy Chemistry*. Vol.1A: Proteins: Basic aspects. 4th Edn. Springer Publication.
- McSweeney PLH and O'Mahony JA. 2016. *Advanced Dairy Chemistry*. Vol.1B: Proteins: Applied Aspects. Springer Science + Business Media.

I. Course Title : Advances in Cheese Technology

II. Course Code : DT 526

III. Credit Hours : 2+1

IV. Why this course?

There is an array of cheese varieties; use of different starter cultures can lead to the development of specific cheese variety too. However, the technological principles involved in Cheddar cheese making are common to several varieties of cheeses with some modifications. Cheese is getting popularized in India, especially the Pizza cheese variety that is preferentially used as a topping on pizza pie. The functional properties of cheese dictate its end use functionality in food system. Basically, some cheese varieties can be produced by two methods – starter culture and direct acidification. Wheyless cheese making from ultra-filtrated milk concentrate is one unique possibility. There has been trend to produce cheeses having low-fat and low salt for the health conscious consumers.

V. Aim of the course

To impart advanced knowledge on milk coagulants, theory of milk coagulation, the technology, biochemistry and microbiology of cheese.

VI. Theory

Unit I

Rennet coagulation: Measurement of milk clotting activity and gelation properties, Catalytic mechanism and milk-clotting properties of rennet and rennet substitutes. Advances in renneting of milk; recombinant rennet.

Unit II

Acid coagulated milk gels: formation, rheology, structural properties, etc.

Unit III

Advances in cheese starters; genetics of Lactic Acid Bacteria (LAB); Exo Polysaccharide (EPS) starters; Genetic engineering of LAB.

Unit IV

Biochemistry of cheese ripening: Metabolism of residual lactose and lactate, protein hydrolysis, lipid hydrolysis, amino acid catabolism; Development of cheese flavour, and body and texture; Cheese microstructure. Accelerated cheese ripening.

Unit V

Mold-ripened cheeses; Starter cultures, technology, ripening process (Blue, Roquefort, Camembert, etc.)

Unit VI

Low fat and low-sodium cheeses: challenges, strategies and advances; Membrane technology in cheese; Cheese as an ingredient in food systems.

Unit VII

Technology of non-bovine cheese: popular varieties, challenges, strategies; Technology of cheeses prepared by coagulation other than rennet and acid (Ricotta, Brown whey cheese, etc.); Advances in cheese packaging; Automation in cheese making; Cheese analogues.

VII. Practical

- Instrumental determination of rennet coagulation time
- Rheology of acid-coagulated milk gels
- Fermentation dynamics of common cheese starters
- Evaluation of cheese ripening behaviour
- Manufacture of mold ripened-, low sodium-, low fat-cheeses
- Manufacture of Goat and Ewemilk cheeses
- Manufacture of Ricotta cheese
- Microstructure of cheese

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Be able to manufacture various varieties of cheeses
- Try to employ various non-thermal pre-treatment to milk to obtain value added cheese
- Be able to develop low-calorie and low-salt cheeses
- Recommend the cheese makers for appropriate mechanization

IX. Suggested Readings

- Jana AH and Thakar PN. 1996. Recombined milk cheeses – A review. *Australian Journal of Dairy Technology*, **51**(1), 33-43.
- Jana AH and Tagalpallewar GP. 2017. Functional properties of Mozzarella cheese for its end use application – A Review. *Journal of Food Science and Technology,* **54**(12), 3766-3778.
- Johnson ME, Kapoor R, McMahon DJ, McCoy DR and Narasimmon RG. 2009. Reduction of sodium and fat levels in natural and processed cheeses: Scientific and technological aspects. *Comprehensive Reviews in Food Science and Food Safety*, **8**(3), 252-268.
- Lucey JA and Singh H. 1997. Formation and physical properties of acid milk gels: a review. *Food Research International*, **30**(7), 529-542.
- Mc Sweeney PLH. 2004. Biochemistry of cheese ripening. *International Journal of Dairy Technology*, **57**(2 3), 127-144.
- Mc Sweeney PLH, Fox PF, Cotter PD and Everett DW. (Eds.) 2017. *Cheese: Chemistry, physics and microbiolo*gy, 4th Edn, Vol. 1, Academic Press.

Websites

- Cheeses and related cheese products – Proposal to permit the use of ultra-filtered milk-https://federalregister.gov/documents/2005/10/19/05-20874/cheeses-and-related-cheese-products-proposal-to-permit-the-use-of-ultrafiltered-milk
- Go cheese to add new products in its portfolioBW Businessworld-http://businessworld.in/article/GO-Cheese-To-Add-New-Products-In-Its-Portfolio/10-07-2018-154382
- American Cheese Society: Serving the Cheese Industry-https://cheesesociety.org/
- Cheese: Dairy Processing Handbook-https://dairyprocessinghandbook.com/chapter/cheese