

SEMESTER-I

Paper No.	Subject	Title	Instruction Hrs/Wk	Credits	Exam Hrs	Max. Marks		
						IA	Exam	Total
FT-1.1	Core -1	Fundamentals of Nutraceuticals and Post-Harvest Management of Fruits and Vegetables	04	04	03	25	75	100
FT-1.2	Core -2	Principles of Food Processing	04	04	03	25	75	100
FT-1.3	Core -3	Nutrition and Therapeutic foods	04	04	03	25	75	100
FT-1.4	Core-4	Food Chemistry and Food Toxicology	04	04	03	25	75	100
FT-1.5	Core – 1 (Practical)	Fundamentals of Nutraceuticals and Post-Harvest Management of Fruits and Vegetables	02	02	03	--	50	50
FT-1.6	Core -2 (Practical)	Principles of Food Processing	02	02	03	--	50	50
FT-1.7	Core -3 (Practical)	Nutrition and Therapeutic foods	02	02	03	--	50	50
FT-1.8	Core-4 (Practical)	Food Chemistry and Food Toxicology	02	02	03	--	50	50

SEMESTER-II

Paper No.	Subject	Title	Instruction Hrs per Wk.	Credits	Exam Hrs	Max. Marks		
						IA	Exam	Total
FT-2.1	Core -1	Analytical Techniques, Sensory Evaluation and Biostatistics	04	04	03	25	75	100
FT-2.2	Core -2	Food Microbiology and Rapid detection methods	04	04	03	25	75	100
FT-2.3	Core -3	Processing of Cereals, Pulses, Oil seeds and Bakery Technology	04	04	03	25	75	100
FT-2.4	Core-4	Food Quality Control and Quality Assurance	04	04	03	25	75	100
FT-2.5	Core – 1 (Practical)	Analytical Techniques, Sensory Evaluation and Biostatistics	02	02	03	--	50	50
FT-2.6	Core -2 (Practical)	Food Microbiology and Rapid detection Methods	02	02	03	--	50	50
FT-2.7	Core -3 (Practical)	Processing of Cereals, Pulses ,Oil seeds and Bakery Technology	02	02	03	--	50	50
FT-2.8	Core-4 (Practical)	Food Quality Control and Quality Assurance	02	02	03	--	50	50

SEMESTER-III

Paper No.	Subject	Title	Instruction Hrs/Wk	Credits	Exam Hrs	Max. Marks		
						IA	Exam	Total
FT-3.1	Core -1	Dairy Technology - Processing of Milk and Milk products	04	04	03	25	75	100
FT-3.2	Core -2	Processing of Meat, Poultry and Fish products	04	04	03	25	75	100
FT-3.3	Core -3	Food Packaging Technology	04	04	03	25	75	100
FT 3.4	Core-4	Processing of Beverages, confectioneries and chocolate products						
FT-3.5	Interdisciplinary	Nutraceuticals	02	02	03	10	40	50
FT-3.6	Core – 1 (Practical)	Dairy Technology - Processing of Milk and Milk products	02	02	03	--	50	50
FT-3.7	Core -2 (Practical)	Processing of Meat, Poultry and Fish products	02	02	03	--	50	50
FT-3.8	Core -3 (Practical)	Food Packaging Technology	02	02	03	--	50	50
FT-3.9	Core-4 (Practical)	Processing of Beverages, confectioneries and chocolate products						
FT-3.10	Skill Development		02	02	03	--	--	--
FT-3.11	Socially Relevant		02	02	03	--	--	--

SEMESTER-IV

Paper No.	Subject	Title	Instruction Hrs per Wk	Credits	Exam Hrs	Max. Marks		
						IA	Exam	Total
FT-4.1	Core -1	Food Engineering and Entrepreneurship	04	04	03	25	75	100
FT-4.2	Core -2	Food Biotechnology and Food Nanotechnology	04	04	03	25	75	100
FT-4.3	Specialization	Waste recycling, Renewable energy utilization, automation in food industry and Research methodology	04	04	03	25	75	100
FT-4.4	Core – 1 (Practical)	Food Engineering and Entrepreneurship	02	02	03	--	50	50
FT-4.5	Core -2 (Practical)	Food Biotechnology and Food Nanotechnology	02	02	03	--	50	50
FT-4.6	Specialization (Practical)	Waste recycling, Renewable energy utilization, automation in food industry and Research methodology	02	02	03	--	50	50
FT-4.7	Project/ Dissertation		02	06	03	50	100	150

SEMESTER I


Davangere University

Department of Studies in Food technology

The Courses in the 2016-17 (CBCS) syllabus based for Skill based, Employability and entrepreneurship

S. No.	Course in the Food Tech programme	Course objective for Skill based /employability/ entrepreneurship oriented	Outcome of the course for potential skill, employability and entrepreneurship
1	FT-1.2. Principle of food processing	Skill based learning and employability	Train students and make them skillful and employable in food industries
2	FT-1.4. Food chemistry and Food Toxicology	employability	Provide employability in food safety and analytical labs
3	FT-2.1. Analytical techniques and sensory evaluation	Employability	Provide employability in food safety and analytical labs
4	FT-2.3. Processing of Cereals, pulses oil seeds and bakery Technology	Skill based learning	Make students skillful in handle and operate Food processing units. Increase chance of employability in food and industries.
5	FT-2.4. Food quality control and quality assurance	Employability	Provide employability in food safety and analytical labs
6	FT-3.2. Processing of meat , poultry and fish products	Skill based learning	Make students skillful in handle and operate Food processing units. Increase chance of employability in food and industries.
7	FT-3.3. Food packaging Technology	Employability	Provide student best employable opportunity in food packaging system at various food industries
8	FT 3.4. Processing of beverages, confectionaries and chocolate products	Skill based learning	Make students skillful in handle and operate Food processing units.

			Increase chance of employability in food and industries.
9	FT-4.1. Food engineering and entrepreneurship	Entrepreneurship	Facilitate students for opening supporting systems for food industries or start their own small/medium/ large scale manufacturing units.
10	FT 4.3. Waste recycalying, renewable energy utilization, automation in food industry	Skill based learning	Facilitate students for opening supporting systems for food industries or start their own manufacturing units.


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FT: 1.1 Fundamentals of Nutraceuticals and Post-Harvest Management of Fruits and Vegetables

Fundamentals of Nutraceuticals

Introduction to phytonutrients and antinutrients: sources, functional foods, therapeutic properties of nutraceuticals in fruits and vegetables, rhizomes and tubers, legumes, cereals, oil seeds, nuts and spices.

Classification of phytonutrients: Nutraceutical activities and chemical properties of carotenoids, phytosterols, vitamin C, vitamin E, omega-3-fatty acids, ferulic acid, asthaxanthin, isoflavones, flavonoids and lignans.

Free radical scavengers: Mechanism and biological role of antioxidant molecules, antioxidant enzymes, selenoenzymes and seleno-compounds. Antioxidants as radio protectors.

Phytoestrogens: Environmental estrogens or xenoestrogens. Biological and chemical importance of phytoestrogens. Isolation, purification and characterization of lignans, mammalian lignans and isoflavonoids. Protective role of isoflavonoids in chronic disease mechanisms of action, estrogenic or antiestrogenic properties. Behavioral effects of endocrine-disrupting phytoestrogens. Measurement of phytoestrogens in biological fluids.

Safety, adverse effects and interactions of nutraceuticals: Safety data, general adverse effects, drug interactions, carnitine and acetyl-L-carnitine, soy isoflavones, catechins, melatonin and glucosamine.

Post-harvesting management of Fruits and Vegetables

Fruits and vegetables as living products: Chemical composition, pre and post-harvest changes, desirable characteristics of fruits and vegetables for processing and maturity standards for storage.

Plant growth regulators: Role in relation to storage, physical and chemical treatment to increase the shelf life conditions. Post-harvest diseases and cold defects, controlled and modified storage of fruit and vegetables.

Food additives: Used in fruit and vegetable processing and preservation.

Fruit and vegetable juices: preparation of juice, syrups, squashes, cordials, and nectars; concentrations and drying of juice, packaging of dried fruits and vegetables. Quality control during and after dehydration and fortified soft drinks.

Jams, jellies and marmalades: Jam definition and standards, method of jam manufacture, jelly-extraction of pectin, mechanism of gel formation processing of jelly, processing of some typical jams, jellies and marmalades.

Preserve candies and crystallize fruits: Preliminary processing methods, storage life, changes occurring during frozen storage. Candied glazed and crystallized fruits and improved equipment for manufacture of preserves. Common preserves generally used – other preserves and candied fruits.

Vinegar: General methods of preparation, food standards, quality control and uses.

Pickles and chutneys:Preparation of various types of pickles, theory and practice, preparation of sauces and chutneys, problem related to the shelf-life of pickles and chutneys and their quality control.

Tomato products:Preparation of sauce and ketchup, puree and paste, preparation of various tomato products, their processing, food standards and their quality control.

Pectin: Raw materials; processes and uses of pectin; products based on pectin manufacture and their quality control.

Spices:Spice production, processing, black pepper, green pepper, white pepper, oleoresin and volatile. Cardamom, ginger, chilies, turmeric powder, oleoresin and volatiles. Minor spices - ajwain, coriander, cumin, cinnamon, fenugreek, garlic, mustard, mace and nutmeg, onion, saffron, tamarind, cloves, mint, vanilla, asafetida and of spices. Spices and spice blends: Soluble spices, Spice substitutes for salt in sodium restricted diet, antioxidant activity of spices, microbiological aspects and sterilization of spices, storage of spices and spice extractives.

Practicals

Antioxidant assays- FRAP, DPPH, ABTS and few others.

Determination of total polyphenols, total flavonoids and tannins in biological samples.

Estimation of caffeine in tea and coffee, TF and TR value of tea and total solids.

Volatile oil content of spices. Aromatic compounds in spices, Capsaicin content in chilies, Curcumin content of turmeric.

Study of processing equipment for fruits and vegetable processing, plant-layout, can seaming operation, preparation of fruit juices, squashes, syrups and ready-to-serve beverages. Canning of fruits and vegetables.

Preparation and preservation of value added products from fruits and vegetables.

Preparation of jams, jellies, marmalade, preserves, and candies.

Preparation of pickles, chutneys, and tomato products, drying of fruits and vegetables, quality control of processed products.

Sensory evaluation of prepared products in the laboratory.

Visit to fruit and vegetables processing factories, freezing of foods, Processing of mushroom.

Suggested Readings:

Brian Lockwood, 2007. Nutraceuticals.Pharmaceutical Press, USA.

Shahidi F and Marian Naczki, 2006.Phenolics in Food and Nutraceuticals. CRC Press, Florida.

Haard, N.F. and Salunkhe, D.K. 1975. Postharvest Biology and Handling of Fruits and Vegetables. AVI, Westport.

- Kader, A. A. 1992. Postharvest Technology of Horticultural Crops, 2nd Ed. University of California, Division of Agriculture and National Resources, California.
- Salunkhe, D.K. and Kadam, S.S. Ed. 1998. Handbook of Vegetable Science and Technology. Marcel Dekker, New York, USA.
- Wills, R.B.H., McGlasson, W.B., graham, D., Lee, T.H. and Hall, E.G. 1989. Postharvest: An Introduction to the Physiology and Handling of Fruits and Vegetables. BSP Professional Books, Oxford.
- Bose, T.K. Ed. 1985. Fruits of India: Tropical and Sub-tropical. NayaProkash, Calcutta.
- Dauthy, M.E. 1997. Fruit and Vegetable Processing. International Book Distributing Co. Lucknow, India.
- Hamson, L.P. 1975. Commercial Processing of Vegetables. Noyes Data Corporation, New Jersey.
- Jagtiani J., Chan, H.T. and Sakal, W.S. Ed. 1988. Tropical Fruit Processing Academic Press, London.
- Kadar, A. A. 1992. Postharvest Technology of Horticultural Crops. 2nd Ed. University of California.
- Salunkhe, D.K. and Kadam, S.S. Ed. 1995. Handbook of Fruit Science and Technology: Production, Composition and Processing. Marcel Dekker, New York.
- Salunkhe, D.K. and Kadam, S.S. Ed. 1995. Handbook of Vegetable Science and Technology. Production, Composition, Storage and processing Marcel Dekker, New York.
- Seymour, G.B., Taylor, J.E. and Tucker, G.A. Ed. 1993. Biochemistry of Fruit Ripening. Chapman and Hall, London.
- Srivastava, R.P. and Kumar, S. 1998. Fruit and Vegetable Preservation: Principles and Practices. 2nd Ed. International Book Distributing Co. Lucknow.
- Ting, S.V. and Roussett, R.L. 1986. Citrus Fruits and Their Products. Marcel Dekker, New York.
- Thurme S. Ed. 1991. Food Irradiation. Elsevier Applied Science, London.
- Wills, R.B.H., McGlasson, W.B., Graham, W.B., Lee, T.H. and Hall, E.G. 1981. Postharvest: An Introduction to the Physiology and Handling of Fruits and Vegetables. Granada, U.K.
- Verma L.R and Joshi V.K., 2000. Post-harvest technology of fruits and vegetables handling, processing, fermentation and waste management. Vol. 1 and Vol.2.

SEMESTER I

FT- 1.2: Human Nutrition and Therapeutic foods

Human Nutrition

Concept of nutrition: Malnutrition, geriatric nutrition and health. Minimum nutritional requirement and RDA-formulation and dietary guidelines reference men, women and adult consumption unit.

Energy in human nutrition: Idea of energy and its unit, energy balance, assessment of energy requirements - deficiency and excess, determination of energy in food, B.M.R and its regulation and S.D.A.

Growth and development from infancy to adulthood: Somatic, physical, brain and mental development, puberty, menarch, prepubertal and pubertal changes, Factors affecting growth and development: Importance of nutrition for ensuring and adequate development.

Growth monitoring and promotion: Use of growth charts and standards and preventions of growth faltering.

Nutrition during pregnancy: Factors (non-nutritional) affecting pregnancy outcome, importance of adequate weight gain during pregnancy, antenatal care and its schedule, nutritional requirements during pregnancy and modification of existing diet and supplementation. Deficiency of nutrients-especially energy, iron, folic acid, protein, calcium and iodine. Common problems of pregnancy and their managements, especially - nausea, vomiting, pica, food aversions, pregnancy induced hypertension, obesity, diabetes and adolescent pregnancy.

Nutrition during lactation: Nutritional requirements during lactation, dietary management, food supplements, galactogogues, and preparation for lactation.

Nutrition during infancy: Infant physiology relevant to feeding and care, colostrum and its composition and importance in feeding, initiations of breast feeding, Basic principles of breast feeding, preparation of formula and mixed feeding, importance of breast feeding over artificial feeding.

Introduction of supplementary foods: initiation and management of weaning and baby-led weaning.

Bottle feeding: Circumstances under which bottle feeding is to be given, care and sterilization of bottles.

Management of preterm and low birth weight babies: Nutritional needs of toddlers, preschool, school going children and adolescents and their dietary management.

Principles of diet therapy: Diet for children, men, teenagers, and diabetics. Diet for obesity and underweight, cardiovascular diseases, liver diseases, kidney diseases, anemia and cancer.

Dietician: Responsibilities, Code of ethics and Diet counseling.

Practicals

Determination of blood glucose and hemoglobin content and estimation of total cholesterol, creatinine, inorganic phosphorus in blood and urine. Abnormal constituents in urine. Diet plan for diabetes and other lifestyle diseases.

Suggested Readings:

B. Srilakshmi, 1999, Food Science. Third Edition, New Age International Publishers. New Delhi.

N. ShakuntalaManay, M. Shadaksharaswamy, 2005, Foods- Facts and Principles. Second Edition, New Age International Publishers. New Delhi.

Norman N. Potter, H.H. Joseph, 1988, Food Science. Fifth Edition, An Aspen Publication. Maryland.

M. McWilliams, 2011, Foods- Experimental Perspectives. Seventh Edition, Prentice Hall publishers. USA.

FT- 1.3: Fundamentals of Food Processing Technology

Introduction: Scope and importance of food processing. National and international perspectives, historical development of food processing and preservation, Food biodeterioration and methods of preservation.

Preservation by heating: Principles of the method, types of microorganisms, bacterial load, sterilization and commercial sterility, thermal resistance of the microorganisms and enzymes.

Canning and bottling: General aspects of canning and bottling, processing operations exhausting and sealing, retorting, ultra-high temperature processes, determination of thermal process time, processing equipment, canning and bottling of various food products.

Refrigeration and freezing preservation: Refrigeration and storage of fresh foods, major requirements of a refrigeration plant, controlled atmospheric storage, refrigerated storage of various foods, freezing point of selected foods influence of freezing and freezing rate of the quality of food products methods of freezing storage and thawing of frozen foods.

Drying and dehydrations: Sun drying of various foods, water activity and its effect on the keeping quality, sorption isotherms and their use. Characteristics of food substances related to their dehydration behavior, drying phenomenon, factors affecting rate of drying, methods of drying of various food products, type of driers and their suitability for different foods; intermediate moisture food processing.

Concentration (evaporation): Application in food industry, processes and equipment for manufacture of various concentrated foods and their keeping quality, properties of liquid, single and multiple effect evaporation.

Food irradiation: Sources of radiations, effect on microorganisms and different nutrients. Radiation units and doses for foods, dose requirements for radiation preservation of foods, safe limits, irradiation mechanism and survival curve, irradiation of packaging materials.

Microwave heating: Principles and application in food processing. Cold Plasma Technology in food preservation.

Chemical preservation: Preservation of foods by use of sugar, salt, chemicals, antibiotics and smoking. Effect of various food processing operations on the nutrients of foods.

Novel food production and processing: Mushrooms, blue green algae, leaf protein concentrates, protein from petroleum yeast, food analogues-edible insects.

Practicals

Estimation of carotenoids, lycopene, anthocyanins, ascorbic acid in biological samples.

Sterilization methods, microwave heating, preservation by canning, drying and dehydration, refrigeration and freezing and few.

Suggested Readings:

Y.H. Hui, 2006. Handbook of Fruits and Fruit Processing, Blackwell Publishing. Iowa, USA.

Jennylynd James, 2006. Microbial Hazard Identification In Fresh Fruit and Vegetables, John Wiley and sons, Inc., Publication. Canada.

Norman N. Potter, H.H. Joseph, 1988, Food Science. Fifth Edition, An Aspen Publication. Maryland.

M. McWilliams, 2011, Foods- Experimental Perspectives. Seventh Edition, Prentice Hall publishers. USA.

FT- 1.4: Food Chemistry and Food Toxicology

Food Chemistry

Food chemistry: Introduction, definition and importance of water in food, water activity and shelf life of food.

Carbohydrates: Sources, Classification, structure and properties of carbohydrates, role of carbohydrates in food industry, chemical reactions, functional properties of sugar, starch, cellulose, glycans, hemicelluloses, gums, pectin substances, polysaccharides, browning reaction in foods. Dietary requirements of carbohydrates, effects of excess and deficiency in diabetes.

Proteins and amino acids: Classification, Sources, structure, distribution (milk protein, egg proteins, meat proteins and fish muscle proteins, oil seed proteins and cereal protein,) physical and chemical properties, functional properties of proteins in foods, factors affecting protein system, purification and denaturation of proteins. Protein-protein interaction, protein-lipid complexes and protein-carbohydrate complexes. Dietary requirements of proteins, effects of excess and deficiency in Kwashiorkor.

Metabolic antagonist and allergens: Significance of presence and functions.

Lipids: Classification and physicochemical properties of food lipids. Refining of crude oils.

Hydrogenation and winterization: Vegetable and animal fat, margarine, lard, butters. Frying and shortening. Flavor changes in fats and oils, lipid oxidation, factors affecting lipid oxidation, auto-oxidation and its biological significance,

dietary requirements, effects of excess and deficiency in cardiovascular diseases.

Enzymes: Nature, classification and properties of enzymes in general food enzyme in particular enzyme activity in different food systems, commercial availability. Food enzyme technology immobilization of enzymes, removal of toxicants through enzymes and flavor production by enzymes.

Minerals: Role of minerals in food industry, effects of various processing treatments. Effects excess if any and deficiency.

Vitamins: Role of vitamins in food industry, effects of various processing treatments. Effects of excess, if any, and deficiency.

Biological changes in foods: Plant pigments and their roles in food industry, bitter substance and tannins. Chemistry of browning reaction in foods, enzymic and non-enzymic browning in foods.

Food Toxicology

Naturally occurring toxicants in foods: Sources, definition, toxicants in pulses, cereals, milk, vegetables, toxic effect on health and methods of prevention.

Chemical contaminants in food: Sources, chemical properties of contaminants, type of chemicals, toxic effect on health, sign and symptoms, digestion absorption of each chemical and prevention of contamination in foods.

Heavy metals: Metabolism of mercury, lead, cadmium, arsenic and aluminum. Analysis of heavy metals and treatments.

Insects encounter in food supply: Introduction of insects, nature of damage and contamination, activities on food supply, toxic effect on food and human health.

Pesticides contamination of foods: Introduction, need for pest control and types of control methods used, types of pesticides and their mechanism of action, residues in food, soil, water and air, residue analysis, health and environmental impact of pesticides such as organochlorides, organophosphates, carbomates, heterocyclic compounds, chlorinated phenolics, amides and urea, mechanism of pesticides, absorption to soil and organic matter. Pesticides residues in water and food. Low sensitivity of tests hides residues. Residue analysis procedures-preparation, extraction of laboratory samples of contaminated food and non-fatty food and removal of residues.

Goitrogens: Clinical disorders, detection of food allergens, specific food allergens in grains, vegetables, fruits, nuts, seeds and beans.

Cyanogens: Sources, clinical disorders, chemistry of cyanogen, toxicology of cyanogenic plant and prevention.

Lathyrogens: Sources, clinical disorders, detection of lathyrogens, mode of action and prevention.

Aflatoxins: Introduction, types of aflatoxins, occurrences of toxin, production in foods. Relative toxicity and mode of action of aflatoxins, their control and inactivation. Analysis of aflatoxins by TLC, column chromatography, spectrophotometer, ELISA and flourometric measurements.

Miscellaneous food allergens and prevention of allergy.

Practicals Determinations of proteins, starches, sugars, amino acids, crude fibre, total minerals, crude fat and water in foods. Determination of minerals-calcium, phosphorus, iron, estimation of vitamins-ascorbic acid, carotene and thiamine.

Analysis of lipids-saponification value, acid value and iodine value.

Browning reaction in food. Determination of tannins and antioxidants.

Estimation of preservatives, chemical residues and aflatoxins.

Suggested Readings:

Aurand, L.W. and Woods, A.E. 1973. Food Chemistry. AVI, Westport.

Birch, G.G., Cameron, A.G. and Spencer, M. 1986. Food Science, 3rd Ed. Pergamon Press, New York.

Fennema, O.R. Ed. 1976. Principles of Food Science: Part-I Food Chemistry. Marcel Dekker, New York.

Meyer, L.H. 1973. Food Chemistry. East-West Press Pvt. Ltd., New Delhi.

Potter, N.N. 1978. Food Science. 3rd Ed. AVI, Westport.

SEMESTER-II

FT: 2.1 Advanced Analytical Techniques, Sensory Evaluation and Biostatistics

Advanced Analytical Techniques

Preparation of chemical solutions: Concept of molar, molal and normal solutions; pH – Importance and measurement of pH. Buffers- Preparation of some common buffers and importance.

Proximate composition and chemical Analysis: Moisture, fat (FFA, IV, PV, RM) protein, fiber, carbohydrate, ash, starch, reducing and non-reducing sugars, vitamins, minerals, density, specific gravity and others in foods.

Dialysis and molecular weight determination: By viscosity, sedimentation and light scattering methods. Thermal processing of food: Differential scanning calorimetry (DSC), X-ray analysis and X-ray crystallography-Principles, working, applications, advantages and disadvantages.

Chromatographic techniques: principles, types (partition and adsorption chromatography.), working, applications (plant pigments-carotene, chlorophyll and anthocyanin as an example.), advantages and disadvantages.

Refractometry: Principle, working types and applications.

Rheology measurements: Introduction, rheological parameters (e.g. viscosity-concept of stress and strain, Newtonian fluids, non-Newtonian fluids, pseudo-plastic, dilatant, plasticity, thixotropic and rheopexy, laminar and turbulent flow). Factors affecting rheological parameters, Rheological instruments for fluids and applications.

Electrophoretic Techniques: General principles, types, working principles, applications, advantages and disadvantages.

Colorimetry and Spectroscopy: Beers - Lambert's Law and extinction coefficient. General principles of colorimeters and spectrophotometers, color of foods and its measurement, atomic spectroscopy, emission spectroscopy, IR spectroscopy, NMR and mass spectroscopy, fluorimetry, spectrofluorimetry, flame photometry and atomic absorption spectrophotometry and electron spin resonance (ESR) spectroscopy.

Enzymatic methods of food analysis: Enzymatic hydrolysis, enzymatic determination of substrate, enzymatic activity and application of enzymes in food industry. Rapid methods of microbial analysis, immunoassays, PCR and comet assay, Southern blotting, Western blotting, polarimetry, patch-clamp technique, centrifugation and tracer technique.

Radioisotopes: Production and applications, advantages and disadvantages.

Radioactivity: Radioactive decay, counting techniques, counting devices, isotopic dilutions, neutral activation analysis, irradiation technology, food irradiation and their applications and radioimmuno assay.

Biostatistics

Measurements: Nature of measurements, types of measurement scale, frequency distribution and graphical presentation of data.

Measures of central tendency: Computation of mean, median and mode, and their uses.

Presentation of data: Frequency distribution, graphical presentation of data by histogram, frequency polygon, frequency curve and cumulative frequency curve.

Central tendency and measures of dispersion: Mean mode, median, and their properties (without derivation), mean deviation, stand deviation and coefficient of variation. Simple correlation, correlation coefficient, simple and multiple regression.

Principles of experimental designs: randomized block and Latin designs and analysis of variance (ANOVA).

Tests of significance: t – test, z – test, X tests for goodness of heterogeneity and independence of attributes, F – test.

Computer applications: Computer applications in food technology, use of computers for documents preparation and presenting, spreads sheets, appropriate statistical and other relevant packages, response surface methodology and Internet.

Practicals

Importance of sampling and techniques of sampling, determination of starch and pectic substances using different methods.

Estimation of proteins by electrophoresis, sugars by HPLC and free fatty acids by GLC. Estimation of antinutritional factors including gossypol, trypsin inhibitor, phytic acid and others.

Determination of food additives in foods. Detection of adulteration in foods. Estimation of toxins and pesticide in foods. Rheological properties of foods. Estimation of toxin traces in food samples.

Suggested Readings:

Joslyn, M.A. Ed. 1970. Methods in Food Analysis. Academic Press, New York.

King, R.D. Ed. 1978. Developments in Food Analysis Techniques-1. Applied Science Publishers Ltd., London.

Morris, C.J. and Morris, P. 1976. Separation Methods in Biochemistry 2nd Ed. Pitman Pub., London.

Plummer, D.T. 1971. An Introduction to Practical Biochemistry. Mc-Graw Hill Pub. Co., New York.

Raghuramulu, N., Madhavan Nair, K., and Kalyanasundaram, S. Ed. 1983. A Manual of Laboratory Techniques. National Institute of Nutrition, ICMR, Hyderabad.

FT 2.2: Food Microbiology and Rapid detection methods

Food Microbiology

Introduction to food microbiology:History, micro-organisms in natural food products and their control,sources of contamination such as air, water, soil, sewage, post-processing contamination and principles of microbial spoilage.

Classification of foods and general principles involved in their preservation.Physical and chemical factors influencing destruction of microorganisms.Biochemical changes caused by micro-organisms, deterioration of various types of food product.

Contaminants of foods-stuffs, vegetables, cereals, pulses, oilseeds, milk and meat during handling and processing.

Growth properties, reproduction, physiological characteristics of fungi, mold, yeast, lactic acid bacteria, lactose metabolism and citrate fermentation. General characteristics, importance, and classification of different genus: *Lactococcus*, *Streptococcus*, *Leuconostoc*, *Lactobacillus*, and other acid bacteria.

Basic understanding of the families of *Bacillus*, *Enterobacteriaceae* (*Enterobacteria*), *coliforms* (*E.coli*) and *Acetobacteriaceae* (Acetic acid bacteria) and *Pseudomonaceae*-*Pseudomonas* as examples.

Food poisoning:Food poisoning by *Staphylococcus*, *Bacillus*, *Listeria* and *Salmonella* spp., *Clostridium botulinum*, *Streptococci*, *Escherichia coli*, *Clostridium perfringens*, mycotoxins, growth and survival of microbes in foods.

Food borne toxicants: Mycotoxins, microbial food fermentation and standards for different foods. Spoilage of canned foods, cereal foods, meat, egg, fish and poultry products, fruits and vegetables, wines, beer and fermented foods.

General characteristics of microorganisms: Classification and identification of yeast, molds and groups of bacteria important in food Industry.

Destruction of microorganisms: Use of heat, chemicals, ionizing irradiation, UV light, and microwave energy in control.

Pre-and probiotics:Interactions of gut bacteria, probiotics and their applications.Role of short-chain fatty acids in human health.

Rapid detection methods

Introduction to pathogenic organisms and their toxins,need for rapid methods, their classification,conventional detection methods- separation and concentration techniques, membrane filtration- direct Epifluorescent technique (DEFT), immunomagnetic separation (IMS), radiometric method, serology and immuno- and radioimmuno assay, lysis inhibition test (LIT), passive immune hemolysis (PIH).Biosensor's-bioluminescence, biosensors, Impedimetry (electrical impedance), piezoelectric biosensors, flow cytometry, solid phase cytometry, electronic nose, immunological methods, nucleic acid based assays-DNA hybridization, polymerase chain reaction and DNA micro- assay using gene chip technology.

Practicals

Microscopy and micrometry. Preparation of nutrient media, sterilization and inoculation techniques, isolation of pure culture, microbial examination of

natural food products, identification of food pathogen in water, milk, cereals, pulses, oilseeds, meat and poultry.

Follow up of bacterial growth in batch culture, different methods of microbial cultivation, mass transfer across membrane and permeability coefficient. Measurement of B.O.D and C.O.D. Fermenter operation and measurement, Production of starter and baker's yeast culture, microbial production of alcohol (cereal based), alcoholic beverages, citric acid, acetic acid and lactic acid, enzymes and amino acids. Visit to effluent treatment plant.

Suggested Readings:

Branen A.L. and Davidson, P.M. 1983. Antimicrobials in Foods. Marcel Dekker, New York.

Jay J.M. 1986. Modern Food Microbiology. 3rd Edn. VNR, New York.

Robinson, R.K. Ed. 1983. Dairy Microbiology. Applied Science, London.

Stanbury P.P. and Whitaker, A. 1984. Principles of Fermentation Technology. Pergamon Press, Oxford UK.

Steinkraus, K.H. 1983. Handbook of Indigenous Fermented Foods. Marcel Dekker, New York.

FT: 2.3 Food Quality Control and Quality Assurance

Introduction to rules, regulations and procedural methods to start up an industry: Importance and functions of quality control and quality assurance.

Quality parameters and evaluation procedures: Appearance, color, texture, viscosity, consistency, flavor, defects, bacterial contamination and foreign matter.

Methods of quality assessment of food materials: Fruits, vegetables, cereals, dairy products, meat, poultry, egg and processed food products, food additives and their specification.

Raw materials and finished product quality: Specification of raw materials and finished products, quality assurance, water standards and analysis of physical, chemical and microbiological characteristics of water.

Statistical quality control: Introduction, tolerance, loss function, process capability, measurement error, optimum process level, process setting, process control and design of experiments.

History and overview of HACCP: Principles, implementation and maintenance, applying HACCP to the food processing industry, validation and verification of HACCP.

Food adulteration and food safety: Prevention of food adulteration Act, PFA specification for food products, specifications for food additives, coloring matter, preservatives, antioxidants, emulsifying and stabilizing agents, insecticides and pesticides.

Food regulations, grades and standards: Concept of Codex Alimentarius, USFDA, ISO 9000 series and others. Food standards and laws: international and national food laws.

Food Safety: **History of Food Safety measures**, food safety standards authority of India (FSSAI), rules and regulations, Codes of practice, Food Safety management, GMP, GHP, IFS, BRC, SOP, FPO, MMPO AQAP, TID, and others.

Food laws and standards: Trademark, **Concept of Codex Alimentarius Trademark Act**, IPR and patents.

Auditing in Food industry: Necessity of auditing, criteria and qualification of an auditor, Certification Courses, Certifying Bodies in India and abroad.

Practical's

Food Safety, Specifications for food additives; coloring mater, preservatives, antioxidants and emulsifying and stabilizing agents, Analysis of Heavy metals, insecticides and pesticides.

Suggested Readings:

R.E. Hester and R.M, 2001, Harrison, Food Safety and Food Quality. Royal Society of Chemistry, UK.

David H. Watson, 2002, Food Chemical Safety. CRC Press, Cambridge, England.

Mr Phil Learoyd, 2005, Good Manufacturing Practice (GMP), National Blood Service, USA.

FT:2.4 Processing of cereals, pulses, oil seeds and Bakery Technology

Storage technology of Cereals and Grains: Seed storage and deteriorative, conditioning and handling, drying of seeds and quality control of seeds.

Wheat Technology: Introduction, structure, composition, nutritive value, conditioning and milling of wheat. Wheat flour, quality characteristics and its uses in bakery products- bread, biscuits and cakes. Composition of grain and environmental effects on its processing quality, enzymes of wheat and their role in the manufacture of wheat products, principles of wheat milling and its effect on composition of flour, aging, byproducts, chemical improvers-bleaching and maturing agents, property of dough and its theology, manufacture of wheat products bread, biscuits etc. Formulation of premixes for bakery products, Noodles, pasta goods and processed cereal foods for infants.

Malting of cereals: Uses of malt, malt extract and oats technology. Detection of gluten and gluten free products.

Corn Technology: Structure, composition, nutritive value, dry and wet milling, corn flakes, starch, corn syrup. Composition, processing of corn for manufacture of corn grits, meal and flour, manufacture of corn flakes, corn syrup, cornstarch, corn steep liquor, corn oil and canned corn.

Barley: Structure, composition, nutritive value, malting of barley and product development.

Oat: Structure, composition, nutritive value, preparation of oat flakes and oatmeal.

Rice technology: Structure, composition, cooking characteristics, nutritive value, parboiling and milling of rice. Utilization of byproducts- rice bran, rice bran oil, composition of rice grain, varieties of rice, rice milling operations and its effect on nutritive value, cooking quality, byproducts of rice milling and their utilization.

Sorghum: Structure, chemical composition, processing and milling of sorghum.

Pulse technology: Varieties of pulses, toxic constituents of pulses and processed pulse products.

Introduction to legumes and oilseeds: Classification with examples, sources, composition, nutritive value and anti-nutritional factors in legumes and oilseeds, cooking characteristics, product development and storage, processing methods, effect of processing of legumes on their compositions improved technologies of legume processing.

Oil seeds and their processing: composition, processing of oilseeds, extraction and refining of oil, by-product utilization. Technology of protein isolates, concentrates and low-cost protein foods from oil seeds.

Commercial baking technology: Ingredients used in baking, equipment of baking, reactions of baking, manufacturing of bread- kinds of breads, manufacturing of biscuits and cookies, manufacturing of cakes- causes of variation in cake quality, shortened cakes, unsharpened cakes (sponge cakes).

Practicals

Experimental milling, physicochemical tests for flour quality of wheat, rheological properties of dough, test baking, physicochemical tests of rice and evaluation of cooking quality. Milling and parboiling of paddy, dhal milling and visit to dhal mills.

Experiments on anti-nutritional factors in pulses, and extruded products, determination of physical and chemical analysis of fats, oils and fatty acids. Extraction of oil from different sources using different techniques. Basic processing of oils- degumming, refining, bleaching, hydrogenation, interesterification, tempering and others.

Manufacture of shortening, margarine. Preparation of peanut butter. Testing storage stability of fats and oils. Detection of adulteration of fats and oil. Visit to oil extraction refining units.

Determination of physical, chemical and functional properties of various proteins. Preparation of protein concentrates and isolates from different sources. Preparation of protein hydrolysate. Manufacture of texturized vegetable proteins. Preparation of protein gels and expanded products. Development of simulated milk products from soy proteins. Use of vegetable proteins as meal extenders.

Suggested Readings

- Bodwell, C.E. Ed. 1977. Evaluation of Proteins for Humans. AVI, Westport.
- Milner, M., Scrimshaw, N.S. and Wang, D.I.C. Ed. 1978. Protein Resources and Technology. AVI, Westport.
- Salunkhe, O.K. and Kadam, S.S. Eds. 1999. Handbook of World Legumes: Nutritional Chemistry, Processing Technology and Utilization. Volume I to III. CRC Press, Florida.
- Salunkhe, D.K. Chavan, J.K., Adsule, R.N. Kadam, S.S. 1992. World Oilseeds: Chemistry, Technology and Utilization, Van Nostrand Reinhold, New York.
- Blanshard J.M.V., Frazier, P.J. and Galliard, T. Ed. 1986. Chemistry and Physics of Baking. Royal Society of Chemistry, London.
- Chakraverty, A. 1988. Postharvest Technology of Cereals, Pulses and oilseeds. Oxford and IBH, New Delhi.
- Durbey, S.C. 1979. Basic Baking: Science and Craft. Gujarat Agricultural University, Anand (Gujrat).
- Kent, N.L. 1983. Technology of Cereals. 3rd Edn. Pergamon Press, Oxford, UK.
- Mathews, R.H. Ed. 1989. Legumes: Chemistry, Technology and Human Nutrition. Marcel Dekker, New York.
- Pomeranz, Y. Ed. 1978. Wheat: Chemistry and Technology. Am. Assoc. of Cereal Chemist. St. Paul, minnesota.
- Pomeranz, Y. 1987. Modern Cereal Science and Technology. VCH Pub., New York.
- Salunkhe, D.K., Kadam, S.S. and Austin A. Ed. 1986. Quality of Wheat and Wheat Products. Metropolitan Book Co., New Delhi.
- Salunkhe, D.K., Kadam, S.S. Ed. 1989. Handbook of World Food Legumes: Chemistry, Processing and Utilization, (3 vol. set). CRC Press, Florida.
- Hamilton, R.J. and Bharti, A. Ed. 1980. Fats and Oils: Chemistry and Technology. Applied Science, London.
- Salunkhe, O.K. Chavan, J.K., Adsule, R.N. and Kadam, S.S. 1992. World Oilseeds: chemistry, Technology and Utilization. VNR, New York.
- Wolf, I.A. Ed. 1983. Handbook of Processing and Utilization in Agriculture. (2 vol. set). CRC Press, Florida.

SEMESTER-III

FT: 3.1 Dairy Technology - Processing of milk and milk products

Milk industries in India and abroad: Distinctive features of tropical dairying from those of temperate climate, collection and transportation of milk. Identification of milk shed areas and planning procurement, organization of milk collection routes, marketing of milk and milk products. Nutritive value of heat processed fluid milks. Practices for collection of milk- options for collection and preservation of milk at farm, cooling and natural inhibitory substances in milk.

Lactose: Chemistry, properties and utilization in various products.

Milk salts: Technological significance.

Lactoperoxidase system: Effect of milk quality, transportation methods and organization of raw milk transport, reception and preliminary testing of milk at plant.

Processing of market milk: Practices for reception, chilling, clarification, and storage of raw milk. Homogenization of milk and cream separation, pretreatment and theories of homogenization and effect of homogenization on physicochemical properties of milk. Manufacturing of special milks, toned, fortified, reconstituted and recombined milks, flavored milks, vitaminized milks and lactose-hydrolyzed milk.

Bactofugation: Thermal processing of milk, principles of thermal processing, kinetics of microbial destruction, thermal death curve, Arrhenius equation. terminology's used in thermal processing, 'D-value', 'Z-value', 'Q 10-value', and 'Fo-value'.

Process description and definitions: Significance of thermization, Pasteurization (LTLT and HTST concept), vaporization and sterilization and UHT processing of milk- relevance of UHT-processing, description of UHT-plants, direct and indirect, upstream and downstream homogenization and third generation UHT plants.

Technology of fermented milk products: Principles and practices of manufacture, packaging, storage and marketing of Dahi, cultured butter milk, acidophilus milk and others.

Cheese: Manufacture of hard, semi hard, soft and processed cheeses. Storage, grading and marketing of cheese, cheese defects and their control. Marketing strategies in India.

Butter: Manufacture, packaging, storage and marketing of butter; butter defects and their control margarine.

Technology of frozen milk products: Ice cream- Ingredients, preparation, defects and control.

Technology of evaporated and dried milk: Manufacture of evaporated milks and milk powders. Packaging storage defects and their control.

Technology of dairy by products: Utilization of skim milk, buttermilk and whey for the manufacture of casein, lactose and others.

Technology of indigenous milk products: Principles and practices of manufacture, packaging, storage and marketing of ghee, khoa, and milk based foods.

Sanitary aspects: of dairy plant building, equipment and their maintenance. Disposal of dairy plant waste. Application of membrane technology in dairy industry. Principles of enumeration of conventional and emerging pathogens in dairy production and biosensor based techniques for monitoring microbial and non-microbial contaminants in dairy industry. Types and utility of starter cultures and DVS.

Practicals

Experiment on platform test of milk, chemical analysis of milk products, milk pasteurization and sterilization, preparation of cream, butter, cheese, paneer, milk sweets and ice cream. Dairy industry management and project feasibility, plant layout, cost benefit analysis, visit to dairy plants. Milk and milk products- addition of probiotic cultures in curds and quality isolation and identification of probiotic cultures in curds and toned milk.

Suggested Readings:

Considine, D.M. Ed. 1982. Foods and Food Production Encyclopaedia, VNR, New York.

Dey, S. 1994. Outlines of Dairy Technology. Oxford Univ. Press, New Delhi.

MaCrae, R., Robinson, R.K. and Sadler, M.J. Ed. 1993. Encyclopaedia of Food Science, Food Technology and Nutrition Academic Press, London.

Robinson, R.K. (2 vol. set). 1986. Modern Dairy Technology Elsevier Applied Science, UK.

Rosenthal, I. 1991. Milk and Milk Products. VCH, New York. Warner, J.M. 1976. Principles of Dairy Processing. Wiley Eastern Ltd. New Delhi.

Yarpar, WJ. and Hall, C.W. 1975. Dairy Technology and Engineering AVI, Westport.

FT- 3.2: Processing of meat, poultry and fish products

Processing of meat and poultry products: Fresh and processed meat technology. Introduction to abattoir, slaughter and post-mortem of meat yielding animals. Components of carcass include muscles, post-mortem glycolysis, rigor mortis and contraction of muscles. Conversion of muscle of meat, pre- and post-slaughter factors affecting quality of meat, color texture, WHC, organoleptic characteristics, PSE and DFD conditions.

Livestock-Status of poultry industry in India and abroad: Pre-slaughter care, ante-mortem examination, slaughter, dressing and post-mortem. Composition and chemistry of chicken muscle, pre- and post-slaughter and factors affecting poultry meat quality.

Preservation of meat and meat products: Electrical stimulation, chilling and freezing of fresh meat. Cold shortening and thaw rigor. Carcass evaluation and meat grading, nutritive value and packaging of fresh meat.

Introduction of processed meat: Cured, smoked, comminuted and canned products. Meat analogue and their processing. Effect of processing parameters

on product constituents such as lipid, protein, carbohydrates, flavour and sensory attributes.

Preservation of poultry meat: Chilling and freezing processing of poultry meat, packaging and grading of poultry meat, preparation of poultry products, cured, smoked and canned, barbecued and curried poultry.

Preparation of egg products: Eggs structure, composition and nutritive value of egg. Egg proteins, functional properties of egg white and yolk, factors affecting egg quality and their measurements, industrial uses of eggs, collection, grading cleaning washing, packaging and transportation of eggs, preparation of egg products, preservation of shell egg, microbial spoilage of egg and egg products.

Fisheries management: Fishing practices, fishery economics and marketing, technology transfer, climate change and its impact on fisheries and livelihood.

Fish products: Global commercial fisheries resources, production trends, food and feeding habits, types of feed, feeding rate, feed and feeding equipment, age and growth, mortality, maximum sustainable yield, hatchery technology and grow out systems.

Fish processing technology: Fish catching methods, fish handling, grading, chilling, freezing, canning and packaging. Machinery for handling and processing.

Fish nutrition and biochemistry: Major and minor constituents of fish – Nutrient composition, proteins, carbohydrates, lipids and fatty acid profiles, vitamins and minerals. Digestive enzymes, digestibility and glycolytic cycle.

Principles and methods of fish preservation: sanitary and phyto-sanitary requirements for maintenance of quality, quality management of fish and fishery products, microbial contamination of fish and methods of prevention. Post-mortem changes in fish, national and international organizations for food standards.

Preservation Technology: Processing engineering, refrigeration cycle and cold store, processing unit construction and waste management-utilization of fish waste such as, fish ensilage, compost, sauces, protein hydrolysates, fish albumin and pet foods (in brief).

Practicals

Slaughtering and dressing of meat animals, study of post-mortem changes, meat cutting and handling and evaluation of meat quality. Estimation of meat to bone ratios, preparation of meat products, canned, dehydrated and barbecued sausages, loaves and burger. Pickling of meat and shelf-life studies on processed meat products.

Experiments on dehydration, freezing, canning, curing, smoking and pickling of fish. Evaluation of quality and grading of eggs, preservation of shell eggs and fish finger.

Suggested Readings:

Lawrie, R.A. 1975. Meat Science, 2nd Edn. Pergamon Press, Oxford UK.

Lavie A. 1980. Meat Handbook.4th Edn. AVI, Westport.

Portsmouth, J.I. 1979, Commercial Rabbit Meat Production. 2nd Edn.SaigaSurvey,England.

Stadelmen, W.J. and Cotterill, O.J., 1977. Egg.Science and Technology.2nd Edn.AVI, Westport.

FT- 3.3: Food Packaging Technology

Introduction to packaging: Packaging operation, package-functions and design.

Principle in the development of protective packaging.

Deteriorative changes in foodstuff and packaging methods for prevention, shelf life of packaged foodstuff, methods to extend shelf-life.

Materials used for Packaging: Rigid containers and corrosion-free containers like thermo- formed semi-rigid containers including tin plates, steel, aluminum containers, and glass containers.

Flexible packaging materials:Primary packaging materials and their properties, different types of paper, paperboard, plastics, cellulose films, metalized films, co-extrusion, lamination, pouches, wrappers, bags, sacks, wraps,shrink packaging, aseptic and retortable pouches, flexible and laminated pouches, cans, bottles, cartons, tubes, glass containers. Secondary packaging materials such as wooden containers, drums and barrels, other traditional packagelike crates, plywood and wire bound boxes, corrugated and fibre board boxes, textile and paper sacks. Special problems associated with packaging of food stuff, consideration in the packaging of perishables and processed foods. Use of biodegradable packaging andactive packaging materials.

Process of Packaging:Evaluation of packaging materials and package performance, packaging equipment, package standards and regulation.Material handling, filling air removal, sealing, retorting, Modified atmosphere packaging, vacuum and gas packaging.Package sterilization techniques, cushioning, unitizing, palletizing, stacking and containerization.

Food Labeling and Bar coding.

Quality Control: Evaluation of packaging materials, toxicity, corrosion prevention, shelf life testing, minimization of transport losses, hazards in handling, storage, packaging and their minimization, packaged product quality and shelf life.

Practicals

Techniques of quality assessment of fruits, vegetable, cereals, dairy products, meat, poultry, milk and other processed products, selection and training of sensory panel.

Hedonic rating of food.

Identification and ranking of food product attributes sensory and instrumental methods for measuring food attributes.

Assessment of strength properties of packaging materials, water vapour and gas transmission rate of flexible packaging materials.

Identification and chemical resistance of plastic films. Pre-packaging of vegetables.

Estimation of shelf-life of packaged food stuff. Familiarization of types of packaging material.

Suggested Readings

Amerine, M.A. Pangborn, R.M., and Rossler, E.B. 1965. Principles of Sensory Evaluation of Food. Academic Press, New York.

Birk, G.G., Herman, J.G. and Parker, K.J. Ed. -1977. Sensory Properties of Foods. Applied Science, London.

Charalambous, G. and Inglett, G. 1981. The Quality of Foods and Beverages. (2 vol.set). Academic Press, New York.

Furia, T.E. Ed. 1980. Regulatory Status of Direct Food Additives. CRC Press, Florida.

Krammer, A. and Twigg, B.A. 1970. Quality Control for the Food Industry. 3rd Edn. AVI, Westport.

Pattee, H.E. Ed. 1985. Evaluation of Quality of Fruits and Vegetables. AVI, Westport.

Ranganna, S. 1986. Handbook of Analysis and Quality Control for Fruits and Vegetable Products. Tata McGraw Hill, New Delhi.

Tannenbaum, S.R. Ed. 1979. Nutritional and Safety Aspects of Food Processing, marcel Dekker, New York.

Painy, F.A. and Painy, H.Y. 1983. A Handbook of Food Packaging. Leonard Hill, Glasgow, UK.

Scicharow, S. and Griffin, R.C. 1970. Food Packaging. AVI, Westport

FT: 3.4 Processing of beverages, confectioneries and chocolate Products

Importance of plantation crops:Chemical composition and processing of tea, coffee, cocoa and their quality assessment.

Beverage: Introduction and classification, beverage ingredients - carbohydrates, fructose, glucose syrup, and high fructose corn syrup.

Intense sweeteners in soft drinks:Acesulfame K, aspartame, alitame, cyclamate, neohesperidinedihydrochalcone, sucralose, neotame, saccharine and stevioside.

New sweeteners and bulking agent in soft drink:Inulin, fructooligosaccharide, polydextrose and trehalose.

Water:Requirements, treatment, impurities and their effect.

Acidulants: Citric acid, tartaric acid, phosphoric acid, lactic acid, acetic acid, malic acid, and ascorbic acid.

Flavorings: Water miscible and water dispersible flavorings.

Preservatives:sulphur dioxide, benzoic acid and benzoates, sorbic acid and sorbates. Mention the other ingredients like colors, stabilizers and antioxidants.

Non-carbonated Beverages: Introduction, dilutable beverages- ingredients, manufacturing operation, filling and packaging. Make a survey on - Ready to drink non-carbonated products in the market.

Carbonated beverages: Ingredients, carbon dioxide production- Fermentation and direct combustion, carbonation.Syrup preparation, de-aeration, carbonators. Filling principles- Gravity fillers counter pressure filler, volumetric fillers and process control.

Alcoholic beverages:Introduction to distillation, wine production, wine variety, fermentation and other operations.

Beer: Raw materials and manufacturing procedure,distilled spirit, whisky, brandy, rum, gin and vodka.Aperitifs and Liqueurs.

Cider:Special types of cider, harvesting and processing, fermentation of cider, secondary fermentation, maturation and final processing. Microbiology of apple juice and cider.

Stimulating beverages:Coffee:production, processing, chemical composition, Instant coffee, monsoon coffee and others. Tea:leaf processing, composition of tea and Instant tea.

Cocoa: Introduction, processing and composition of Cocoa beverages.

Functional drinks containing herbal extracts: Herbal extraction process-infusion, decoction, tincture, liquid or fluid extract, soft extract, powdered extract, percolation, modern extract, organic extract. Extraction characteristics and their problems and absorption of drink.

Niche drinks: Alcoholic type drinks, energy drinks,functional drinks with nutraceuticals and sports drinks.

Confectioneries and chocolate products: introduction, ingredients- sugar from cane, guar, khandasari sugar, raw sugar, refined sugar, white sugar, beet sugar,

forms of sugar, liquid sweeteners, reactions of sugar and sugar based confectioneries.

Chocolate confectionery: Cocoa beans, chocolate liquor, cocoa butter, cocoa bean processing and chocolate manufacturing plant operations.

Sugar Glasses in the chemistry of boiled sweets: Formulation and manufacture of boiled sweets. Grained sugar products: fondant, fudge, chocolate covered liqueur sweets.

Pan coating: Hard panning, soft panning, problems in coating almonds and other nuts. Glazing - Polishing and tableting.

Toffees and Caramels: Cooking types, processing and toffee as an ingredient of other products.

Chewing gum: Ingredients and preparation, gelled products and liquorice.

Aerated products: Marshmallows and Nougats

Lozenges: Ingredients and manufacturing.

Indian Confectionery: Confectionery manufacturing practices and confectionery as a source of energy.

Practicals:

Construction of Glucose-Fructose calibration curve, determination of activity of yeast invertase, Estimation of Sulphur dioxide in beverages, Estimation of Phenolic substances, Estimation of ascorbic acid, Determination of suspended solids, sodium benzoate, acidity, salt content in beverages, Preparation and associated tests (Wine, Beer, Whisky etc).

Suggested readings:

Paul R. Dittmer, 2003. Principles of Food, Beverage and Labor cost controls, Seventh Edition. John Wiley and Sons, Inc. Canada.

E.K. Arendt, 2008. Gluten free cereal products and beverages, First Edition. Elsevier Publishers. London.

D.P.Steen, P.R. Ashurst, 2006. Carbonated Soft drinks: Formulation and Manufacture, First Edition. Blackwell Publication, Iowa-USA.

FT- 3.5: Nutraceuticals (Interdisciplinary)

Introduction to phytonutrients and antinutrients: Sources, definition to functional foods, nutraceuticals pre-and probiotic interactions. Classification of phytonutrients, bioactive components in legumes, cereals, tubers, nuts, fruit and vegetables. Nutraceutical and chemical properties: Carotenoids, phytosterols, vitamin C, vitamin E, omega-3-fatty acids, ferulic acid, asthaxanthin, isoflavones, flavonoids and lignans.

Free radical scavengers: Mechanism and biological role of antioxidant molecules, antioxidant enzymes, selenoenzymes, seleno-compounds and antioxidants as radio protectors.

Alpha-linolenic acid: Metabolism, role in immunoregulation, tumorigenesis, metastasis and other functions.

Phytoestrogens: Environmental estrogens or xenoestrogens, biological and chemical importance of phytoestrogens.

Protective role of isoflavonoids in chronic diseases: Mechanisms of action, estrogenic and antiestrogenic properties, endocrine-disrupting phytoestrogens and measurement of phytoestrogens in biological fluids.

Isolation, purification and characterization: Lignans and isoflavonoids.

Spices: Production and processing of black pepper, green pepper, white pepper, cardamom, ginger, chilies, turmeric powder, oleoresin and volatiles.

Minor spices: Ajwain, coriander, cumin, cinnamon, fenugreek, garlic, mustard, mace and nutmeg, onion, saffron, tamarind, cloves, mint, vanilla, asafetida and other minor spices.

Safety, adverse effects and interactions of nutraceuticals: Safety data and general adverse effects, drug-receptors interactions, role of carnitine and acetyl-L-carnitine, soy isoflavones, catechins, melatonin and glucosamine.

Suggested Readings:

Brian Lockwood, 2007. Nutraceuticals. Pharmaceutical Press, USA.

Shahidi F and Marian Naczki, 2006. Phenolics in Food and Nutraceuticals. CRC Press, Florida.

SEMESTER- IV

FT- 4.1: Food Engineering and Entrepreneurship

Food Engineering

Food Engineering: Introduction, reaction kinetics in food system, phase transition and transformations in food systems.

Size reduction process: Principles, theories and laws, energy considerations, equipment. Unit operation in food engineering, mass and energy balance, fluid flow, fluid statics, fluid dynamics and fluid flow applications.

Mixing and forming: Theory and applications, mixing indices, equipment for solid and liquid. Fluid flow, laminar, turbulent and transitional ranges velocity distribution profiles, basic equations, and thermal velocity calculations. Size reduction process and classification-mixing, kneading and blending.

Food plant design: General consideration in designing the plant.

Thermal Processing: Death kinetics, thermal death curve, decimal reduction time. Z- Factor, heat penetration curve, process time calculations, mathematical curve, mathematical and graphical solutions.

Evaporation: Heat and mass balance, steam economy, heat recovery, efficiency, process calculations.

Food dehydration: Constant and falling rate periods, drying rate calculations.

Chilling, refrigeration and freezing: Theories, characteristic curve, cooling rate calculations.

Separation processes: Filtration and centrifugation, theories and mathematical descriptions, constant rate and constant pressure filtration, equipment. Mechanical sieving, centrifugation, sedimentation, Mechanical handling-conveying and elevation.

Extrusion: Theory and applications, extrusion cookers and cold extrusion, single and twin-screw extruders, design considerations.

Membrane Technology: Reverse osmosis and ultrafiltration.

Microfiltration: Supercritical gas extraction.

Fortification: Advances in fortification technology, synthetic nutrients, techniques of food fortification and stability of nutrients in relation to processing.

Encapsulations: design and structure of microcapsules, release rate and mechanism. Techniques of micro encapsulation, advantages and application of encapsulation.

Non-thermal Processing: High pressure processing, pulsed electric processing and Ohmic heating. Engineering aspects of radiation processing.

Entrepreneurship

Plant design concepts: General design considerations, feasibility analysis, plant location and location theory models and economic plant size.

Product and process design: Flowcharts and their design, equipment selection, plant layout development and evaluation, planning and design of service

facilities. Requirements in respect of building and building materials. Analysis of plant costs and profitability: Network analysis of planning, scheduling and management activities.

Human resource planning: Planning and design of marketing system, worker's safety and plant hygiene.

Introduction to Marketing and economics: Demand and supply, sample survey techniques, marketing information, consumer trends, consumer behavior. Introduction to operations Research: Definition and applications. Inventory control, linear programming and queuing theory.

International trade: Basis, trends and composition of India's foreign trade. Institutes for promotion of Indian agricultural and horticultural trade and export inspection agencies. Export documentation and procedures required.

Role of Institutes: Export and Import, Banks and ECGC (Export Credit Guarantee Corporation).

Marketing and business administration: Principles of marketing and business administration, patents and trademarks, statutory rules, health regulations, Indian and foreign regulations. Export regulations. Trade Act regulations relating to maintaining hygienic conditions. Export and inspection agencies. Nature, objectives and scope of financial management: Financial planning and control, capital structure, recent developments in financial management.

Case studies of select importing countries: Food, agricultural and horticultural products, their import and inspection regulations, and payment procedures usually followed.

Practicals

Application of psychometric charts in food engineering, Generation of steam and its applications, Measurement of pressure, and flow of fluids. Study of heat exchangers, dryers, elevating and conveying equipment. Size reduction equipment's, and sieve analysis.

Food plant design, Study of mechanical separators, Kinetics of fruit and vegetable dehydration, Visit to food processing plants.

Marketing and business administration -Flowcharts and their design.

Suggested Readings:

Batty, J.C. and Folkman, S.L. 1983. Food Engineering Fundamentals. John Wiley and Sons, New York.

Fennema O.R. Ed. 1985, Principles of Food Science: Part-II Physical Principles of food Preservation. Marcel Dekker, New York.

Harper, J.C. 1975. Elements of Food Engineering. AVI, Westport.

Heldman, D.R. and Lund, D.B. Ed. 1992. Handbook of Food Engineering marcel Dekker, New York.

Export/import policy by Govt. of India, Export/import data by DGCIS-Calcutta and Export documentation by Nashi Publication.

FT: 4.2 Food Biotechnology and Food Nanotechnology

Food Biotechnology

History and development of biotechnology: Introduction, application of genetics to food production. Methods of molecular cloning, immobilization of microbial and cultured plant cells.

Microbial culture selection: Production of amino acids like lysine and glutamic acid, antibiotics like penicillin, streptomycin and tetracycline, production of microbial enzymes and organic acids. Methods for laboratory fermentations, isolation of fermentation products, immobilized microbial cells and fine chemicals. Strain improvement, culture preservation and inoculum development, microbes used in agribiotechnology for livestock and transgenic plants production. Introduction to bio-insecticides, candidate microbiology insecticides, bio-fertilizers, inoculant manufacture, diagnostic and clinical microbiology applicable to emerging and re-emerging infectious diseases with a special emphasis on culture and sensitivity, microbes used in production of alternative energy, microbial endophytes and novel metabolites.

Isolation, preservation and maintenance of industrial microorganism: Kinetics of microbial growth and death, product decomposition and effect of environmental conditions. Bioreactors: Media for industrial fermentation, types of fermentation processes, analysis of batch, fed-batch and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial populations and specialized bioreactors (pulsed, fluidized, photo-bioreactors and others).

Measurement and control of bioprocess parameters: Basic principles of feedback control, proportional, integral and derivative control.

Introduction to downstream processing: Principles of downstream processing, small, medium and large scale processing, bacterial starter culture, methods of inoculum, and medium preparation, slurry processing and product isolation. Technological aspects of industrial production of beer, wine, enzymes amylase, pectinase, proteases, organic acids, amino acids, vitamins, antibiotics, baker's yeast, single cell protein. Removal of microbial cells and solid matter, foam preparation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying and crystallization.

Enzymes and cell immobilization and their industrial applications: Use of microbes in mineral beneficiation and oil recovery.

Industrial production of chemicals: Alcohol (ethanol), acids (citric, acetic and gluconic) and solvents (glycerol, acetone and butanol) production.

Bioprocess technology: Beer brewing, cheese manufacture, mold-modified foods, wine and vinegar. The fermentation process, procedure and equipment. Fermented food: origin, scope and development, sauerkraut, yoghurt, cheese, miso, tempeh, idly, dosa. Regulatory and social aspects of biotechnology of foods, application of enzymes in food industry, production of food flavor, colour, enzymes, immobilized enzyme and use of probiotics. GMO, GMC, GMF concepts and principles.

Genetically modified organisms and foods: Concepts and principles, pros and cons GM foods and regulatory protocols.

Food Nanotechnology

Introduction to nanotechnology: Nanoparticles and types of Nanoparticles.

Preparation of Nanoparticles: Polymerization based methods, polymer precipitation methods, amphiphilic macromolecules cross linkages.

Characterization of Nanoparticles: Size and shape, specific surface morphology, surface charge and electrophoretic mobility, surface hydrophobicity, density, molecular weight measurement of nanoparticles, recovery and nutraceutical incorporation efficiency.

Instrumentation in Nanotechnology: Principles and applications of Zetasizer, Ultrasonicator, DSC, AFM, STM, TEM, XRD and FTIR.

Carrier concepts in drug delivery: Liposomes, multiple emulsions, resealed erythrocytes, solid lipid nanoparticles, copolymerized peptide nanoparticles, nanocrystals and nanosuspensions, aquasomes and dendrimers.

Drug delivery: Introduction to parenteral delivery, molecular basis of targeted drug delivery, bio-conjugates and chemical drug delivery.

Surface engineering of nanoparticles: Steric stabilized nanoparticles (stealth), bio-adhesive nanoparticles, magnetic nanoparticles and nanoparticles coated with antibodies.

Nanoparticles uptake: Studies on *in vitro* and *in vivo* uptake mechanisms of nanoparticles.

Nutraceutical loading and *in vitro* release profile: Release of lipophilic and hydrophilic nutraceuticals.

In vivo fate and distribution of nanoparticles: Factors affecting the bio-distribution of nanoparticles.

Applications of Nanoparticles: (a) Nanotechnology in pharmaceuticals, cosmetology and agriculture, precision farming, smart delivery system and (b) nanotechnology in food industry, food packaging, food safety and food processing.

Nanotoxicology:

Practicals

Method of plant cell culture, Preparation of starter culture, Preparation of beer, wine, tempeh, yoghurt, vinegar. Production of amylase, pectinase, proteases, flavour, colour by fermentation. Immobilization of enzymes.

Food Nanotechnology practical

Suggested Readings:

Bains W. 1993, Biotechnology from A to Z, Oxford Univ. Press, Oxford.

Crueger, W. and Crueger A. 1984. Biotechnology: A Textbook of Industrial Microbiology. Science Tech. Madison, USA.

Joshi, V.K. and Pandey, A. Ed. 1999. Biotechnology. Food Fermentation, (2 Vol. set). Education Publ. New Delhi.

Knorr, D. 1982. Food Biotechnology. Marcel Dekker, New York.

Branson, R.E. and Norvell, D.G. 1983. Introduction to Agricultural Marketing McGraw Hill Book Comp., New York.

Chowdhry, N.K. and Aggarwal, J.C. 1994. Dunkel Proposals. Vol. III. Shipra Pub., New Delhi.

Darrah, L.B. 1971. Food Marketing. The Ronald Press Comp. New York.

Kacker, M. Ed. 1982. Marketing and Economic Development, Deep and Deep Pub., New Delhi.

Rich, S.U. 1970. Marketing of Forest Products: Text and Cases, McGraw Hill Book Comp., New York.

Shepherd, G.S. 1947. Marketing of Farm Products. The Iowa State College Press, Ames, Iowa. Practicals

FT: 4.3 Waste recycling, Renewable energy Utilization, automation in food industry and Research methodology

Waste recycling system

Waste and its consequences: In pollution and global warming.

Agrochemicals and pesticides in agriculture and processing: Purpose, classification and methods of dispensing them, characteristics and estimations.

Types of food processing wastes and their present disposal methods: Treatment of plant waste by physical, chemical and biological methods.

Effluent treatment plants: Use of waste and waste water, sewage water treatment chemical measure of water pollution, conventional biological treatment, role of microphytes and macrophytes in water treatment. Recent approaches to biological waste water treatment, BOD and COD.

Aquatic environment management: Bioremediation, pollution and its control.

Solid waste management: Types, availability and utilization of by-products of cereals, legumes and oilseeds, utilization of by-products from fruits and vegetables processing industries, sugar and agro based industries, and brewery and distillery waste.

Status and utilization of dairy by-products: whey, buttermilk and ghee residues, availability and utilization of by-products of meat industry, poultry industry and fish processing units.

Bio-composting process: use of composted materials. Biomethanation and biocomposting technology for organic waste utilization, incineration and efficient combustion technology, integration of new and renewable energy sources for waste utilization.

Biological control: Use of biological techniques in controlling air pollution and removal of chlorinated hydrocarbons from air.

Biofuels: Plant derived fuels, biogas, landfill gas, bioethanol and bio-hydrogen.

Renewable energy utilization

Energy for Food Processing: Concerns of the current millennium, renewable energy utilization, desirability, feasibility and the niches. Integrated renewable energy sources for process heat availability.

Solar energy resources: Solar furnace, solar thermal and solar photovoltaic technology for electricity and heat generation and solar cell technologies for decentralized energy generation.

Passive solar architectural and solar active system: Used in refrigeration and cooling, solar drying of fruits and vegetables, applications of hybrid solar dryer for industrial use and utilization of solar furnaces and concentrators.

Wind turbine technology: An overview on wind energy development, wind energy utilization for process heat and electricity generation.

Bio-energy resource: Biomass as source of alternative energy, biomass conversion, gasification systems for process heat, biogas for electricity and other industrial energy, ethanol fermentation, liquid fuel from biomass process. Combustion technologies: Improved cook stoves and furnace technology.

Automation in food industry

Introduction: Food quality evaluation, indication variables, elastography, electronic nose and tongue in marbled meat, intramuscular fat and wavelet.

Concept and system for data acquisition: Data analysis, data processing, image acquisition, image processing and ultrasonic B-mode imaging.

Robotics: System integration, application of robotics and basic components of robotics and features of II and III generation robots.

Automation in different units of food processing: Preparation of raw food and materials, sorting, grading, size reduction, mixing and agitation, thermal processing, dehydration, packaging, CIP and quality control.

Research Methodology

Scientific approach to research: Meaning, significance, types of research studies.

Research Process: Formulating the problem, objectives, hypothesis, research design, sample design, collecting data, analysis of data, interpretations, preparation of report.

Sampling design: Census vs. sample survey, steps, types, scaling techniques, reliability, validity and scale construction techniques.

Methods of data collection: Observation, interview, questionnaire, case study and focused group discussion.

Processing of data: Development of Code book. Thesis writing and submission.

Practicals

Extraction of banana fiber Utilization of butter milk powder in bakery products, utilization of ghee residue in caramel toffee, extraction of volatile oils from organic waste, use of crop residue for the production of cellulose, use of mango kernels for manufacturing of starch and production of pectin from organic waste. Various treatments in use for waste disposal and study on operational precautions.

Learn on experiments related to use of solar cells and solar collectors for industrial applications, various design of biogas for motive power generation and producer gas generator, industrial level natural convection and forced convection type solar dryer, improved biomass furnaces for process heat, industrial level biomass cook stoves, hybrid renewable energy devices for process heat, bio-diesel production and utilization.

Food odor measurement, Continuous snack food frying quality, sampling for detection peanut off flavors, snack food frying data acquisition for process control, elastographic imaging for meat quality evaluation. Linear statistical dynamic modeling for snack food modeling, learn on automatic food dehydration plant, automatic extrusion plant, automatic evaporation and puree processing plants and automatic CIP systems.

Suggested Readings:

NIIR Board. 2001. *Modern Technology of Agro Processing & Agricultural Waste Products*. National Institute of Industrial Research Publ.

Rathore NS & Panwar NL. 2007. *Renewable Energy for Sustainable Development*. New India Publ. Agency.

Teri 1993. *Rays of Hope: Renewable Energy for Sustainable Development*. Tata Energy Research Institute, New Delhi.

Chaturvedi P. 2000. *Energy Management: Challenges for the Next Millennium*.

Energy Conservation through Waste Utilization, American Society of Mechanical Engineers, New York.

Kreit F & Goswami DY. 2008. *Energy Management and Conservation Handbook*. CRC Press.

Murphy WR & McKay G. 1982. *Energy Management*. BS Publ.

Patrick DR. 1982. *Energy Management and Conservation*. Elsevier

Publ. Patrick DR., Fardo SW, Richardson RE & Steven 2006.

Energy Conservation Guidebook. The Fairmont Press.

Wulfinghoff DR. *Energy Efficiency Manual*. Energy Institute Press.

Considine 2001. *Process Control*. AVI Publ.

Huang Y & Lacey RE. 2003. *Principles of Robotics*. CRC.

Huang Y, Whittaker AD & Lacey RE. 2001. *Automation for Food Engineering*. CRC.