

NEW AND RESTRUCTURED PG CURRICULA & SYLLABI, 2009

Horticulture Science

M.Sc Horticulture and Ph. D. programmes in Postharvest Technology

DEPARTMENT OF POSTHARVEST TECHNOLOGY



Submitted by

Department of Postharvest Technology
(Faculty of Agriculture)
KERALA AGRICULTURAL UNIVERSITY

NEW AND RESTRUCTURED PG CURRICULA & SYLLABI,2009

M.Sc Horticulture (Postharvest Technology)

DEPARTMENT OF POSTHARVEST TECHNOLOGY

| CODE | CORSE TITLE | CREDI TS |
|------------------------|--|---------------------|
| [A] | MAJOR COURSES | [20] |
| * PHT 501 | Post harvest management in fruits and vegetables | 2+1 |
| * PHT 502 | Advances in fruit and vegetable preservation | 2+1 |
| * PHT 503 | Processing and value addition of plantation crops & spices | 2+1 |
| * PHT 504 | Processing and value addition of medicinal and aromatic plants | 2+1 |
| * PHT 505 | Sensory evaluation and quality control in processing of horticultural produce | 1+1 |
| PHT 506 | Entrepreneurship development with emphasis on establishing horticulture based processing industries | 2+0 |
| *PHT 507 | Packaging of fresh and processed horticultural produce | 2+1 |
| *PHT.508 | Post harvest physiology of fruits and vegetables | 1+0 |
| [A] | TOTAL CREDITS FOR MAJOR COURSES | [20] |
| [B] | TOTAL CREDITS FOR MINOR COURSES | [9] |
| [C] | TOTAL CREDITS FOR SUPPORTING COURSES | [5] |
| [D] | TOTAL CREDITS FOR NON-CREDIT COURSES | [6] |
| [E] PHT 591 | TOTAL CREDITS FORMASTER' S SEMINAR | [1+0] |
| | TOTAL CREDITS FOR COURSE WORK | 41 |
| [F] PHT 599 | TOTAL CREDIT FOR MASTER' S RESEARCH | 20 |
| | GRAND TOTAL CREDITS FOR M. Sc. COURSE (41+20) | 61 |

*** Compulsory Courses for M.Sc Horticulture (Postharvest Technology)**

[A] MAJOR COURSES

***PHT 501: POST HARVEST MANAGEMENT IN FRUITS AND VEGETABLES: 2+1**

Objective

To facilitate deeper understanding on the principles and practices of post harvest management in fruit and vegetable crops.

Theory

Introduction to post harvest technology of fruits and vegetables- Current Indian scenario of post harvest sector- Importance of post-harvest handling.

Physical and chemical changes during maturity and ripening; Factors leading to post harvest losses.

Pre harvest factors affecting quality and shelf life

Harvest indices, harvesting methods, machines and practices for specific market requirements.

Pre-cooling- Types, importance, methods etc.

Treatments prior to shipment viz, washing, sanitization, waxing, curing, grading of fruits and vegetables for local markets and export. Equipments for washing, sizing, grading. Role of biocontrol agents and natural plant products.

Packaging techniques for local and export market. Standards and specifications for fresh produce.

Principles, uses, structures and equipments, methods and requirements of storage, viz; ventilated, refrigerated, MAS, CA and hypobaric storage. low cost storage structures & rural technologies of storage. Viz., ZECC Storage disorders and spoilages.

VHT and irradiation treatment of fruits and vegetables

Principles of transport and commercial transport operations. Modes of transportation, types of vehicles, transit requirements for different horticultural produce.

Marketing - Factors influencing marketing of perishable crops, marketing systems and organisations.

Practical

Varietal evaluation for enhanced shelf life and processing quality. Determination of maturity of fruits and vegetables by different methods- visual, physical, chemical, computational etc. Determination of physiological loss in weight. Chemical analysis of fruits and vegetables at different stages of maturity and ripening. Protective skin coating with wax emulsion and pre and post-harvest treatment with fungicides, chemicals and growth regulators to extend the shelf life of fruits and vegetables. Prepackaging studies. Control of sprouting of potato and

onion by using growth regulators. Study of effect of pre-cooling on shelf-life and quality of fresh fruits and vegetables. Study of packages - bulk and consumer packs for different fruits and vegetables. Visit to packaging centres, cold storage and CA storage units, local markets, cooperative, super markets dealing with marketing of perishables.

Suggested readings

- Bhutani, R.C. 2003. *Fruit and Vegetable Preservation*. Biotech Books.
- Chadha, K.L. & Pareek, O.P 1996. (Eds.). *Advances in Horticulture*. Vol. IV. Malhotra Publ. House.
- Chattopadhyaya SK. 2007. *Handling, transportation and storage of fruits and vegetables*. Gene-Tech books, New Delhi.
- FAO. 2007. *Handling and Preservation of Fruits and Vegetables by Combined Methods for Rural Areas- Technical Manual*. FAO Agr. Ser. Bull., 149.
- John, P.J. 2008. *A Handbook on Postharvest Management of Fruits and Vegetables*. Daya Publishing House. Delhi.143.
- Haid ,N.F. & Salunkhe, S.K 1997. *Post Harvest Physiology and Handling of Fruits and Vegetables*. Grenada Publ.
- Kadar AA.1992. *Post-harvest Technology of Horticultural Crops*. 2 Ed. University of California.
- Lloyd Ryll A. and Pentzer WT. 1982. *Handling, transportation and storage of Fruits and vegetables*. Second edition (Vol-2). AVI Publishing Company, Connecticut.
- Mitra, S.K 1997. *Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits*. CABI.
- Ryall, A.L. and Pentzer, W.T 1982. *Handling, Transportation and Storage of Fruits and vegetables*. Vol.2, Fruits and Tree Nuts., AVI Pub. Co. Westport
- Salunkhe DK, Bolia HR & Reddy NR. 1991. *Storage, Processing and Nutritional Quality of Fruits and Vegetables*. Vol. I. *Fruits and Vegetables*. CRC.
- Saraswathy S, Preeti JL, Balasubramanyan S, Suresh J, Revathy N and Natarajan S. 2008. *Post harvest management of horticultural crops*. AGRIBIOS (India).
- Sudheer, K.P. & Indira ,V 2007. *Post Harvest Technology of Horticultural Crops*. New India Publ. Agency.
- Ranganna ,S 1997. *Hand Book of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill.
- Thompson AK. 1995. *Post Harvest Technology of Fruits and Vegetables*. Blackwell Sci.
- Verma, L.R. and Joshi, V.K 2000. *Post harvest Technology of Fruits and vegetables: Handling, Processing, Fermentation and Waste Management*. Indus Publ. Co.

***PHT 502 : ADVANCES IN FRUIT AND VEGETABLE PRESERVATION : 2+1**

Objective

To educate the principles and practices of processing and product diversification of fruits and vegetables.

Theory

Introduction to processing of fruits and vegetables. Present status and future prospects of fruits and vegetable preservation industry- Indian and global scenario.
Spoilage of fresh and processed produce, biochemical changes and enzyme associated with spoilage, spoilage causing organisms, food poisoning and their control measures.
Principles and importance of fruit and vegetable processing. Primary and minimal processing. Processing equipments.
Layout and establishment of vegetable processing industries. acquiring FSSAI registration/licence. Nutrition labeling
Methods of preservation by heat, drying, chemicals, irradiation, freezing, fermentation, etc.
Advanced processing methods
Food additives- classification and functions
Important fruit and vegetable products.
Utilization of byproducts of fruit and vegetable processing industries. Subsidiary products (Amchur, papain etc.) -Waste management in processing factory.
Innovations in processing- extracts, powders, flavours, aromatics and phyto - pigments.
Convenient foods viz., powders, concentrates, IQF, fres-cuts etc.
Quality assurance and quality control. Food laws and standards
Principles and methods of sensory evaluation of fresh and processed fruits and vegetables.

Practical

Preparation and evaluation of various processed products- Dehydrated products, wafers, pickles, sauces, ketchup, fermented products, powders, etc as per food laws and standards, Blanching of vegetables and its effect on enzymes. Chemical analysis for nutritive value of fresh and processed fruits and vegetables. Study of different types of spoilages in fresh as well as processed produce, identification of spoilage causing organisms, Study of biochemical changes and enzyme associated with spoilage, Sensory evaluation of fresh and processed products. Visit to processing units to study the layout, equipment, hygiene, sanitation and byproduct/ waste management.

Suggested readings

Arthey, D & Dennis C. 1996. *Vegetable Processing*. Blackie/Springer-Verlag.
Chadha, D.S. 2006. *The Prevention of Food Adulteration Act*. Confed. of Indian Industry.
FAO. 1997. *Fruit and Vegetable Processing*. FAO.
Gisela, J. 1985. *Sensory Evaluation of Food – Theory and Practices*. Ellis Horwood.
Graham, H.D. 1980. *Safety of Foods*. AVI Publ. Co.
Hildegrade, H & Lawless, H.T. 1997. *Sensory Evaluation of Food*. CBS.
Lal, G., Siddappa G.S and Tandon, G. 1986. *Preservation of Fruits and Vegetables*. ICAR, New Delhi.
Luh, B.S and Woodroof, J.G. 1975. *Commercial Vegetable Processing*. AVI Publishing Co.
Mahindru, S.N. 2004. *Food Safety: Concepts and Reality*. APH Publ. Corp.
Ranganna, S. 1986. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw Hill.
Shapiro, R. 1995. *Nutrition Labeling Handbook*. Marcel Dekker.
Srivastava, R.P & Kumar, S. 2003. *Fruit and Vegetable Preservation: Principles and Practices* (3rd Ed.). International Book Distri. Co.

Tressler & Joslyn, M.A. 1971. *Fruit and Vegetable Juice Processing Technology*. AVI Publ. Co.
Wills, R.H.H., Lee, T.H. Graham, D., McGlasson, W.B and Hall, E.G .1984. *Postharvest: An Introduction to the Physiology and handling of Fruit and Vegetables.*, AVI Pub. Co. Westport.

***PHT 503: PROCESSING AND VALUE ADDITION OF PLANTATION CROPS & SPICES (2+1)**

Objective

To facilitate deeper understanding on the principles and practices of processing and value addition of plantation crops and spices.

Theory

Importance of plantation crops and spices in the economy of state of nation. Commercial uses of spices and plantation crops. Trading of plantation crops, spices and products in domestic and export markets.

Processing and value addition of plantation crops, viz., Coffee, Tea, Cocoa, Cashewnut, Coconut, Oil Palm, Arecanut, Rubber, Palmyrah palm .

Processing and value addition of major spices, viz., Black Pepper, Cardamom, Ginger, Turmeric, Chilli and Paprika.

Processing and value addition of (i) tree spices:- Clove, Nutmeg, Cinnamon, Allspice, Camboge.

(ii) Seed spices and minor spices:- coriander, cumin, fennel, fenugreek, curry leaf and vanilla.

Innovations in value addition of plantation crops: virgin coconut oil, desiccated coconut, spray dried coconut powder, preservation of coconut inflorescence sap etc. Utilization of arecanut spathe for diversified uses. Modern method of chocolate manufacture. Decaffeinated coffee, Green tea, Oolong tea, Organic tea etc. . Hi-tech processing for extraction of essential oils and oleoresins from spices. Encapsulated spice flavours, extruded spices, essences, drops, nutraceuticals, pigment and aromatics.

Practical

Identification of different products of plantation crops and spices. Familiarizing different grades of plantation crops, spices and their products. Preparation of refined coconut oil, preserving tender coconut water and vinegar. Production of clarified juice, syrup and wine from cashew apple. Fermentation of cocoa beans and production of chocolate. Extraction of spice oleoresins and essential oils. Preparation of dried and dehydrated products from spices. Preparation of white pepper. Preparation of spice powders and curry powders. Visit to processing units of plantation crops and spices. Quality control of spices (adulteration in spice products) and plantation products.

Suggested readings

Bavappa, K.V.A., Nair, M.K., Premkumar, T. 1982. *The Arecanut Palm Monograph series*.
CPCRI, Kasaragod.

Chadha KL et al. (Eds.). 1993-95. *Advances in Horticulture*. Vol. IX *Plantation Crops and*

- Spices*. Malhotra Publishing House, New Delhi.
- Coreley, R.H.V., Harden, J.J., Wood, H.J. 1976. *Oil Palm Research and Development*. Crop Science-I. Longman, New York.
- Mandal, R.C. 1997. *Cashew: Production and Processing Technology*. Agro.Bot.
- Masada, Y. 1986. *Analysis of Essential Oil by Gas Chromatograph and Mass Spectrometry*. John Wiley & Sons.
- Peter, K.V. 2001. *Hand Book of Herbs and Spices*. Vols. I-III. Woodhead Publ. Co., UK & CRC, USA.
- Pruthi, J.S. 1993. *Major Spices of India. Crop Management and Post Harvest Technology*. ICAR, New Delhi.
- Thampan, P.K. 1984. *Handbook on Coconut Palm*. Oxford and IBH Pub. Co. New Delhi.

***PHT504: PROCESSING AND VALUE ADDITION OF MEDICINAL AND AROMATIC PLANTS (2+1)**

Objective

To educate the principles and practices of processing and value addition of medicinal and aromatic crops.

Theory

Introduction and scope of medicinal and aromatic crops. Importance of medicinal and aromatic crops in modern medicine, ayurveda and indigenous system of medicine. Prospects of processing and value addition of medicinal and aromatic crops for utilization in the pharmaceutical, nutraceutical, flavour and perfumery industries.

Processing and value addition of medicinal plants, viz., Catharanthus,, Dioscorea, Solanum, Datura, Rauwolfia, Acorus, Digitalis, Ephedra, , Opium Poppy, Cannabis, Neem, Kaempferia, Plumbago, Alpinia, Adhatoda, Isabgol, Liquorice, Aloe, Safed musli, Sapan wood, Withania, Gloriosa, Stevia, Coleus.

Processing and value addition of aromatic plants, viz., - Lemon grass, Palmarosa, Vetiver, mint, Rose, tube rose, Rosemary, Eucalyptus, Sandalwood, Geranium, Jasmine, Patchouli, Lavender, Tulsi, Davana, Citronella etc.

Extraction and analysis of active principles using TLC, GC, HPLC, Hydro-distillation, solvent extraction, enfleurage. Utilization of active principles of medicinal plants in the pharma sector. Study of aroma compounds of aromatic plants and their utilization in the perfumery industries. Quality control & standard specifications in essential oils
Nano-processing technology in medicinal and aromatic plants.

Practical

Harvesting of medicinal and aromatic plants. Primary processing, drying and storage. Secondary processing for extraction of active principles from medicinal plants and extraction of oils/oleoresins from aromatic plants. Identification of active compounds of medicinal plants/ odouriferous compounds of aromatic plants by using TLC, GC, GC-MS, HPLC and other hi-tech equipment. Physico-chemical and sensory evaluation of oils, oleoresins and other extracts. Developing different value added products from medicinal and aromatic plants.

Suggested readings

- Chadha, K.L. and Gupta, R. 1995. *Advance in Horticulture* Vol. 11 Medicinal & Aromatic plants. Malhotra Pub. House, New Delhi.
- Handa, S.S. and M.K. Kabal. 1996. *Supplement to Cultivation and Utilization of Medicinal Plants* RRL (CSIR) Jammu- Tawi.
- Kirthikar, K.R. and Basu, B.D. 1993. *Indian Medicinal Plants*, Vol. 1-4. Lalit Mohan Basu, Allahabad.
- Kurian, A. and Sankar, M.A. 2007. *Medicinal Plants*. New India Publishing Agency, New Delhi.
- Sudeer, K.P. and Indira, V. 2008. *Post-Harvest Technology of Horticultural crops*, Horticulture Science Series. New India Publ. Agency.

***PHT 505 : SENSORY EVALUATION AND QUALITY CONTROL IN PROCESSING OF HORTICULTURAL PRODUCE (1+1)**

Objective

To educate the principles and concepts of sensory evaluation and quality control of horticultural produce.

Theory

Importance and methods of sensory analysis .

Requirements of sensory evaluation laboratory; Organizing sensory evaluation programme; Panel selection and training.

Analysis for various sensory characters . Appearance, taste, smell, colour, texture and flavour. Role of human senses: 1) Eye/Sight 2) Ear/Hearing 3) Skin/Feeling/Touch 4) Taste Buds/Taste, 5) Olfactory Epithelium/Smell

Different tests for sensory evaluation - Detection, threshold and dilution tests. –Subjective tests: discrimination, descriptive, affective; Flavour profile and tests; Ranking tests.

Role of sensory evaluation in product optimization. Sensory analysis for consumer evaluation. Designing of experiments. Interpretation of results.

Methods of sensory evaluation of different food products. Designing of experiments. Handling and interpretation of data.

Relationship between objective and subjective methods. Computer-aided sensory evaluation.

Concept of quality: Quality attributes- physical, chemical, nutritional, microbial, and sensory; their measurement and evaluation; instrumental vis-à-vis sensory methods for testing quality. Functions and methods of quality assessment of fruits and vegetable products. Specifications for finished products.

Microbial spoilage- Food poisoning- Control measures

Food laws and Quality control. Prevention of Food Adulteration (PFA), FSSAI, ISO accreditation. EurepGAP Certification, SQF 1000, SQF 2000. HACCP, other standards and their importance in Quality Control. GAP, GMP, GLP. Organic Certification.

Practical

Procedure for sensory analysis. Identification of basic taste, odour, texture and colour. Determination of threshold activity. Hedonic testing. Testing of individual and overall quality by ranking. Optimizing a product by sensory analysis. Hi-tech laboratory methods for quality control. Physico-chemical analysis of fresh material and finished products. Microbial load on samples. Quality estimation in processed material through FSSAI estimations. Estimation of nutritive value of fruits and vegetables: Carbohydrate, proteins, fat, vitamins, minerals etc. Analysis of processed products for fibre, flavonoids, vitamins, carotenoids, glucosinolates, fats, antioxidants etc. Visit to incubation centres of food processing and food parks. Procedure for setting up of a processing unit registration and licensing of processing unit with FSSAI. Familiarizing with codex standards.

Suggested Readings

- Amerine MA, Pangborn RM & Rosslos EB. 1965. *Principles of Sensory Evaluation of Food*. Academic Press.
- Early R. 1995. *Guide to Quality Management Systems for Food Industries*. Blackie Academic.
- Furia TE. 1980. *Regulatory status of Direct Food Additives*. CRC Press.
- Jellinek G. 1985. *Sensory Evaluation of Food - Theory and Practice*. Ellis Horwood.
- Krammer A and Twigg BA. 1973. *Quality Control in Food Industry*. Vol. I, II. AVI Publ.
- Lawless HT and Klein BP. 1991. *Sensory Science theory and application in foods*. Marcel Dekker.
- Macrae R, Roloson R and Sadlu MJ. 1994. *Encyclopedia of Food Science & Technology & Nutrition*. Vol. XVI. Academic Press.
- Maslowitz H. 2000. *Applied sensory analysis of food Vol. I & II*. CRC Press.
- O'Mahony, 1985. *Sensory Analysis of Foods : Statistical Methods*. Marcel Dekker, Basal.
- Piggot JR. 1984. *Sensory Evaluation of Foods*. Elbview Applied Science.
- Piggot, J.R 1985. *Sensory Analysis*. Elsevier, Netherlands.
- Rai SC and Bhatia VK. 1988. *Sensory evaluation of Agricultural products*. IASRI, ICAR.
- Ranganna S. 2001. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw-Hill
- Robinson JW. 1970. *Undergraduate Instrumental Analysis*. Marcel Dekker.

PHT506 ENTREPRENEURSHIP DEVELOPMENT WITH EMPHASIS ON ESTABLISHING HORTICULTURE BASED PROCESSING INDUSTRIES (2+0)

Objective

To impart latest knowledge and skills on entrepreneurship development for starting and running horticulture based industrial units and quality standard requirements and certifications.

Theory

Introduction to entrepreneurship development in horticulture. An overview of food processing industry in Kerala and India.

Financial agencies and support for setting up of processing units. Role of commodity boards. Export, import and tax policies and government policies.

Exposure to commercially viable horticulture crops, raw materials and processed products for exploitation in the industrial sector.

Review of trading of horticulture products in domestic and export markets. Opportunities in agri business. Future projections of horticultural products for domestic and export market and scope of entrepreneurship development in fruits, vegetables, spices, medicinal and plantation crops.

Marketing of processed products for domestic and export market and market assessment.

Qualities of an entrepreneur and entrepreneurial development. Basic concepts on commencing small, medium and large processing units.

Product development, product innovation and value addition. Setting up of processing units: project formulation and its management.

Primary, secondary and tertiary processing of horticultural products. How to start and operate a fruit and vegetable processing unit.

Scope of mechanization in processing industry. Machinery requirement for different fruit and vegetable processing units. Role of food parks and AEZ in entrepreneurial growth. Food safety management systems. Food product quality and safety and accreditation of the units for international acceptance viz - Hazard Analysis Critical Control Points, ISO, GMP, GLP, GHP, Global GAP etc.

Suggested and Readings

Acharya SS & Agarwal NL. 2004. *Agricultural Marketing in India*. 4 th Ed. Oxford & IBH.

Girdharilal,G.S.,Siddappa,G.S and Tandon,G.L.1998.Presevation of fruits and vegetables. ICAR, New Delhi.

Hisrich, R.D. and Peters, M.P. 2005. *Entrepreneurship*. Tata Mc Graw- Hill Publishing Co. Ltd, New Delhi.

Kohls RL & Uhj JN. 2005. *Marketing of Agricultural Products*. 9 th Ed. Prentice Hall.

Kotler P. 2002. *Marketing Management – Analysis, Planning, Implementation and Control*. Pearson Edu.

PHT 507: PACKAGING OF FRESH AND PROCESSED HORTICULTURAL PRODUCE (2+1)

Objective

To acquaint and familiarize the process and techniques of packaging fresh as well as processed horticultural produce.

Theory

Introduction, history, function and scope of packaging industry in India. Importance of packaging of fresh and processed horticultural produce

Food packaging systems: Different forms of packaging such as rigid, semi-rigid, flexible forms. Packaging materials– paper based packaging- raw material and types of boxes, corrugated fibre board boxes.

Metal cans : types, fabrication, lacquering, tin quality - classification. Double seaming technology - defects and causes.

Glass containers - types, classification, testing quality - thermal shock resistance, thermal shock breakage, impact breakage.

Flexible packaging materials - types and their properties. Barrier properties of packaging materials. Emphasis on plastics in food packaging

Natural packaging materials

Graphics and package design. Packaging machineries. Bottling and canning operations.

Packaging requirements of fresh and processed horticultural produce- Heat processed foods, Fruit juice, Frozen foods, Freeze-dried Foods, Powders, Instant Foods etc.

Primary, secondary and tertiary levels of packaging.

Skin packaging, shrink packaging, form-fill-seal packaging, aseptic packaging- tetrapacks.

New technology in packaging - Controlled Atmosphere packaging. active/intelligent/smart packaging, Gas filling in packing. Vacuum packing and sealing.

Hermetic sealing. vibra packaging, Palletization, Handling of packages,

Package regulations etc.

Specifications and quality control of packaging materials. Bulk packaging. Future thrust and scope of packaging technology.

Practical

Study of different packaging materials and packaging systems. Evaluation of different packaging materials for their transport worthiness. Ventilation requirement in packing materials with different fruits and vegetables. Determination of water vapour transmission rate (WVTR) and gas transmission rate (GTR) of packaging material. ERH studies of different types of foods. Studies on gas exchange in plastic films. Visits to supermarkets and food malls for familiarizing different types of packaging. Visits to packaging fabrication industries. Visits to hi-tech packaging industries for acquainting packing of cashew nuts, coffee, tea, curry powders, spices, chocolates, processed fruit/vegetable products.

Suggested Readings

Kader, A.A., Kasmire, F.R., Mitchell, F.D., Reid, M.S., Somner, N.F and Thomson, J.F.1985. Post harvest technology of horticultural crops. Agrl. And Natural Resources Pub. U.C. Davis, U.S.A.

Ahvenainen R. 2001. *Novel Food Packaging Techniques*. CRC.

Mahadevaiah M and Gowramma RV. 1996. *Food packaging materials*. Tata McGraw Hill.

Painy FA. 1992. *A handbook of food packaging*. Blackie Academic.

Pantastico B. 1975. *Post Harvest Physiology, Handling and Utilization of Tropical and Subtropical Fruits and Vegetables*. AVI Publ.

Robertson GL. 1992. *Food Packaging -Principles and Practices*. Marcel Dekker.

Sacharow S and Griffin RC. 1980. *Principles of Food Packaging*. AVI Publ.

Salunkhe DK & Kadam SS. 1998. *Handbook of Vegetables Science & Technology: Production, Composition, Storage and Processing*. Marcel Dekker.

- Salunkhe DK & Kadam SS. 1995. *Handbook of fruit Science & Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
- Salunkhe DK, Bolia HR & Reddy NR. 1991. *Storage, Processing and Nutritional Quality of Fruits and Vegetables. Vol. I. Fruits and Vegetables*. CRC.
- Sisir Mitra. 2005. *Post harvest physiology and storage of tropical and sub tropical fruits*. CABI Publishing.

PHT.508: POSTHARVEST PHYSIOLOGY OF FRUITS AND VEGETABLES (1+0)

Objective

To educate the principles of postharvest physiology of fruits and vegetables.

Theory

Structure and composition of fruits and vegetables.
Pre- harvest factors affecting postharvest quality.
Maturity indices for harvest
Physiology of fruit and vegetable development, Postharvest changes in biochemical characters and quality composition.
Postharvest changes- ripening and senescence.
Influence of environmental factors on senescence and ripening. Environmental influence on quality parameters.
Respiration and respiratory climacterics.
Ethylene biosynthesis and action in ripening. Sources of ethylene for ripening. Approaches to manipulate ethylene biosynthesis.
Recommended ripening conditions for different fruits.
Climacteric and non- climacteric fruits and vegetables.
Estimation of respiration rate, ethylene release and quality characters of stored fruits.
Manipulation and regulation of postharvest physiology- ripening, senescence. Extension of storage life of fruits and vegetables
Control of dormancy, sprouting and discolouration in vegetables.
Physiological disorders - chilling & freezing injury, causes & remedies

Suggested Readings

- Pantastico B. 1975. *Post Harvest Physiology, Handling and Utilization of Tropical and Subtropical Fruits and Vegetables*. AVI Publ.
- Singh DK and Singh SK. 2005. *Physiology and post harvest management of horticultural crops*. Agrotech Publishing Academy, Udaipur.
- Sisir Mitra. 2005. *Post harvest physiology and storage of tropical and sub tropical fruits*. CABI Publishing.
- Stawley J. Kays. 1998. *Post harvest physiology of perishable plant products*. CBS Publishers.
- Weichmann J. 1987. *Post harvest physiology of vegetables*. New York and Basel.
- Wills RBH, Mc Glasson WB, Graham D. 2007. *Post harvest –An Introduction to physiology and Handling of Fruits, Vegetables and ornamentals*. University of New South Wales Press.

Ph.D HORTICULTURE (POSTHARVEST TECHNOLOGY)

| CODE | COURSE TITLE | CREDIT S |
|-------------------|--|---------------------|
| A | MAJOR COURSES | [15] |
| ** PHT 601 | Advances in postharvest technology and value addition of fruits and vegetables | 2+1 |
| ** PHT 602 | Advances in on-farm processing, value addition and product diversification of plantation crops | 2+1 |
| ** PHT 603 | Advances in on-farm processing value addition and product diversification of spices | 2+1 |
| ** PHT 604 | Advances in postharvest processing and extraction of active principles in medicinal and aromatic plants | 2+1 |
| PHT 605 | Hi-tech methods in storage, transportation and packaging of fresh and processed horticultural products | 2+1 |
| A | TOTAL CREDITS FOR MAJOR COURSES | [15] |
| | MINOR COURSES | |
| PHT 606 | Microbial spoilage, pesticide residue and post – harvest diseases/ disorders of fresh & processed horticultural produce | 2+1 |
| PHT 607 | Advances in fermentation technology with reference to fruit & vegetable preservation | 2+1 |
| PHT 608. | Technology of food flavours | 1+1 |
| B | TOTAL CREDITS FOR MINOR COURSES | [9] |
| C | TOTAL CREDITS FOR SUPPORTING COURSES | [5] |
| D. PHT 691 | Doctoral seminar-I | 1+0 |
| E. PHT 692 | Doctoral seminar-II | 1+0 |
| | TOTAL CREDITS FOR COURSE WORK(15+8+5+2) | 30 |
| F. PHT 699 | TOTAL CREDIT FOR DOCTORAL RESEARCH | 45 |
| | GRAND TOTAL CREDITS FOR Ph.D PROGRAMME (30+45) | 75 |

**** Compulsory Courses**

A. MAJOR COURSES

PHT 601- ADVANCES IN POSTHARVEST TECHNOLOGY AND VALUE ADDITION OF FRUITS AND VEGETABLES (2+1)

Objective: to teach advances in postharvest technology and value addition of fruits and vegetables.

Theory

Unit 1. Importance of post harvest management and value addition of fruits and vegetables. An overview on the post harvest losses of fresh fruits and vegetables in India. Prospects for value addition and product development in fruits and vegetables. Research on post harvest management and product diversification of fruits and vegetables. Development activities in post harvest sector of fruits and vegetables.- (PHM & processing). Quality control in processed fruits and vegetables.

Unit II - Climacteric and non- climacteric fruits. Respiration and ripening. Ethylene metabolism, its biosynthesis and regulation, Molecular biology of ripening. Changes in enzymes and texture of fruits and vegetables. Studies on installation and physiology of CA and MA storage system

Unit III- Latest technologies in processing and value addition of commercial fruits (Tropical, subtropical and temperate). Recent concepts in processing of fruit juices, juice concentrates, fruit pulp, fermented and unfermented beverages, fruit flavor, aromatics and pigments. Development of new and innovative products in major, minor and under exploited fruits with emphasis on export.

Unit IV- Modern methods in processing and value addition of vegetables for domestic and export markets. Innovations in dried and dehydrated vegetable products. Improved recipes of pickles, sauces, ketchups, vegetable extracts and powders for global trading. Vegetable flavors, essences, aromatics and pigments.

Unit V- Irradiation technology, Vapor heat technology and other advanced technologies in processing of fruits and vegetables. Active packaging, bulk packaging and hi-tech practices for long distance (surface, sea, air) transport of fresh as well as processed fruits / vegetables

Practical

Harvesting of fruits and vegetables for specific requirements. Studies on pre- harvest factors and their effects on quality. Effects on environmental, cultural and varietal factors on post harvest behaviour of fruits and vegetables. Physico- chemical studies on fruits and vegetables prior to harvesting and during post- harvest and ripening stages. Experiments on the role of ethylene in ripening. Physiological and anatomical changes associated with ripening. Practical exercises on developing improved products from fruits and vegetables. Visits to modern processing units and familiarization of unit operations. Visits to quarantine stations, bulk packaging units of shipping and air transporting centers of fruits and vegetables products.

Suggested Readings

Pantastico, E.B (ed.) 1975. *Postharvest physiology, handling and utilization of tropical and subtropical fruits and vegetables*. AVI Pub. Co., Westport.

Ryall, A.L. and Pentzer, W.T.1982. *Handling, transportation and storage of fruits and vegetables*. Vol2. Fruits and Tree nuts. AVI Pub. Co., Westport.

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Sudheer, K.P and Indira, V.2007. *Postharvest Technology of Horticultural Crops*. New India Publ Agency.

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PHT 602- ADVANCES IN ON-FARM PROCESSING, VALUE ADDITION AND PRODUCT DIVERSIFICATION OF PLANTATION CROPS (2+1)

Objective

To keep abreast with the latest innovations in on-farm processing, value addition and product diversification of plantation crops

Theory

Unit 1 . Introduction to the processing and products of plantation crops. Significance of on-farm processing and the quality of finished products. A survey on the plantation industrial sector. Perspectives and scope for improvement.

Unit II. Current scenario on the market infrastructure. Market behavior of plantation products during the past three decades. Products facing stiff competition and means to revive their market potential. Consumer's preferences and requirements for products. Future perspectives in marketing.

Unit III. Recent concepts in value addition and product diversification of plantation crops.

Coconut: Potential and scope of processing fresh coconut. Processing for shelf stable products from coconut milk/cream. Spray dried coconut milk powder defatted coconut powder, desiccated coconut, virgin coconut oil, preservation of tender coconut water, preservation of coconut inflorescence sap. Commercial production of toddy, jaggery, alcohol and vinegar. Latest methods in refining and de-odourizing of coconut oil. Solvent extraction of coconut oil. Coconut based dairy foods-coconut chips, coconut biscuits, nata-de-cocoa, coconut jam, coconut burfi, coconut honey etc. coconut shell products, carvings, novelties and charcoal. Coir manufacturer and coir industry in Kerala, geotextiles.

Oil- palm- pilot processing of oil palm adopted by oil Palm India Ltd.- Need for small scale processing units- Processing technology practiced by NRC Oil Palm Palode. Quality characteristics of palm oil in comparison with coconut oil.

Unit IV. Areca nut- Tender nuts: scope for manufacture of diversified masticatory products. Utilization of by products like furfural and phenolics in industrial sector. Isolation and formulation of alkaloids, viz., arecoline, quavacine, arecolidine etc. for pharmaceutical uses. Diversified uses of areca spathe for production of plates, cups, spoons and other novelties

Cashew nut- small scale processing (cottage industry) of cashew nut in india. H-tech processing, grading, roasted nuts, flavoured nuts and other value-added products. Import of cashew nuts for the processing sector. Trends and scope for exports of cashew nuts. Cashew apple: exploitation for production of unfermented beverages (juice, nector, squash, syrup etc.) cashew apple pickle and fermented beverages (wine, alcohol, feni). Scope of production of byproducts, viz., CNSL, testa tannins.

Unit V. Cocoa- role of varieties and improved strains in quality of processed products .improved methods of fermentation, drying and processing. Cocoa butter, cocoa powder and byproducts. Small scale production of chocolate. Pilot manufacturer of chocolate

Coffee- Role of Arabica, Robusta and other types in quality of processed coffee. Innovations in manufacturer of cherry coffee and powder. Characteristics of parchment coffee and its powder.

Comparison of plain coffee vs. blended coffee (chicory blended). Advantages of specialty coffee. Discussions on branded coffee viz., Decaffeinated coffee, Mysore Nuggets, Plantation A, Peaberry, Extra bold, Monsoonized Malabar, Washed Robusta, CXR Coffee etc.

Tea- problems facing tea production and processing. Scope for mechanization in plucking tea leaves. Orthodox tea: innovation in processing for meeting demand in global markets. Modern manufacturer CTC method and scope of trading CTC in domestic as well as export markets. Specialty tea grades: Organic tea, Green tea, Oolong tea and other popular grades of tea. Chemistry of tea processing

Unit VI. An overview of the natural rubbers industry in Kerala and India. Recent methods in preservation and processing of latex. Innovations in production of sheet rubbers and crepe rubbers. Studies on processing operations and machinery for Technically specified rubber (TSR), Specialty Rubbers viz., super processing rubbers, Constant viscosity NR, Low Viscosity NR, Oil extended Natural rubber (OENR), Graft Natural Rubber, Deproteinised Natural Rubber, Epoxidised Natural Rubber

Unit VII. Competition and challenges for trading of plantation products in the post WTO scenario. Scope for evolving new and innovative products in plantation crops. Role of NIIST, Coconut Board, Rubber board, Oil Palm India Ltd, CPCRI, Tea Board, UPASI, Coffee board, CFTRI, Directorate of cashew etc. on the upliftment of plantation processing sector

Practical

Acquainting the role of crop varieties in preparation of various products. Visits to progressive farmers plots for learning recent trends in on-farm processing. Processing of raw materials of plantation crops in the Lab for preparation of novel products. Quality characterization of plantation products. Visits to the local and export markets for familiarizing the currently traded products and their grades. Visits to processing units and R and D divisions of NIIST, Oil Palm India Ltd, Coconut Board, Coffee board, UPASI, CPCRI, CAMPCO, Nestle, AVT Natural products, Kerala solvent extraction Ltd etc.

Suggested readings

Alice, K and Peter, K.V. 2007. *Plantation crops*. New India Publishing agency

Bavappa, K.V.A., Nair, M.K. and Premkumar, T. 1982. *The arecanut Plant*, CPCRI, Kasragod

Coreley, R.H.V., Harden,J.J and Wood, H.J.1976. *Oil palm research and development, Crop-science-I*. Longman, Newyork

Radhakrishna pillai.1980. *Hand book of natural production in India*. Rubber Board, Kottayam

Shanmughavelu, K.G and MadhavaRao, V,N. 1977. *Spices and plantation crops*. Popular Book Depot, Madras

Thampan, P.K.1984. *Hand book on Coconut palm*. Oxford and IBH publ.Co.,NewDelhi

PHT 603- ADVANCES IN ON-FARM PROCESSING VALUE ADDITION AND PRODUCT DIVERSIFICATION OF SPICES (2+1)

Objective: To keep pace with the latest developments and trends in on-farm processing, value addition and product diversification of spices

Theory

Unit I- Importance of on-farm processing, Value addition and product diversification of spices. An over view of the spices based processing industries in Kerala and India. A statistical reviews of the production, trading , price behavior and earnings by means of marketing of spices and its products for the past three decades. Prospects for value addition, development of innovative products and chances for newer export markets for spices.

Unit II - Adoption of improved on-farm processing methods and selection of choice crop varieties on quality of finished products. Cleaning and grading of harvested/ processed produce at farm level. Effect of pre-treatments viz., blanching, chemical treatments, better drying methods (solar, electric, LPG drying), improved blanching etc. on better physic chemical properties of products.

Unit III- latest technologies in processing, value addition and product development of major spices viz., black pepper, cardamom (small and large), ginger, turmeric, chillies. Recent concepts in the processing of dried / dehydrated spices, brining of fresh spices, frozen/ freeze dried spices, extraction of essential oils, oleoresins, super critical fluid extracts, essences, spice drops, encapsulated flavours, spice powders or curry powders, instant spices, spice pastes etc.

Unit IV- Modern methods in processing, value addition and product development of:

Tree spices- cinnamon, clove, nutmeg, camboge, Allspice, tamarind etc.

Minor spices- vanilla, curry leaf, mango ginger, mint, herbal spices etc.

Seed spices- coriander, cumin, fennel, fenugreek, celery, mustard, poppy seed

Unit V- Quality up- gradation in spices and spice products. Production, processing and certification of organic spices. Establishment of spices based processing units. Discussions on role of institutions like NIIST, IISR, Spices Board, CFTRI and private NGO s on value addition

of spices, Acquiring logo, certificates and license for internal trading and export. Research and development efforts for product diversification of spices. Future thrusts on processing and value addition of spices.

Practical

Stages of harvesting of spices for preparing products viz., dehydrated spices, canning, freezing, freeze-drying, oils, oleoresins, ground spices, brining of spices and other products. Influence of varieties for developing green products, dried/de-hydrated products, spice powders, extraction of active principles and other diversified products. Visits to progressive farms for exposure to newer methods in on-farm processing. Acquainting on-farm operations like cleaning, better drying methods, blanching, bleaching, grading etc. Visits to wholesale markets and export zones for familiarizing the export grades. Distillation of essential oils, extraction of oleoresins, dehydrated spices, brining of spices, spice powders, curry powders, other extracts and products. Preparation of white pepper, dry ginger, dry turmeric, dry chillies etc. Preparation of bleached products from spices. Isolation of active principles from spices, viz., piperine, cineole, esters, curcumin, zingiberone, gingerol, capsaicins, vanillin, eugenol etc. Physico chemical analysis on estimating the quality aspects of various spices. Visits to hi-tech processing units for familiarizing the manufacture of different products. Visits to R and D units of NIIST, Spices Board, IISR, Cochin Spices, Synthite, AVT Natural Products, Kancor, Eastern Spices, CFTRI etc.

Suggested Readings

Agarwal S, Sastry EVD & Sharma RK. 2001. *Seed Spices: Production, Quality, Export*. Pointer Publ.

Arya PS. 2003, *Spice Crops of India*. Kalyani.

Kumar NA, Khader P, Rangaswami & Irulappan I. 2000. *Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants*. Oxford & IBH.

Nybe EV, Miniraj N & Peter KV. 2007. *Spices*. New India Publ. Agency.

Parthasarthy VA, Kandiannan V & Srinivasan V. 2008. *Organic Spices*. New India Publ. Agency.

Peter, K.V. 2001. *Hand Book of Herbs and Spices*. Vols. I-III. Woodhead Publ. Co., UK & CRC, USA.

Pruthi, J.S. 1993. *Major Spices of India. Crop Management and Post Harvest Technology*. ICAR, New Delhi.

Pruthi JS. (Ed.). 1998. *Spices and Condiments*. National Book Trust.

Pruthi JS. 2001. *Minor Spices and Condiments – Crop Management and Post Harvest Technology*. ICAR.

Purseglove JW, Brown EG, Green CL & Robbins SRJ. (Eds.). 1981. *Spices*. Vols. I, II. Longman.

Tiwari RS & Agarwal A. 2004. *Production Technology of Spices*. International Book Distr. Co.

Varmudy V. 2002. *Marketing of Spices*. Daya Publ. House.

PHT 604- ADVANCES IN POSTHARVEST PROCESSING AND EXTRACTION OF ACTIVE PRINCIPLES IN MEDICINAL AND AROMATIC PLANTS (2+1)

Objective: to each advances in postharvest processing and extractions of active principles of economically important medicinal and aromatic plants

Theory

Unit 1. Medicinal and aromatic plants of economic importance. Studies on plant parts and stage of harvesting for extracting active principles. Primary processing of harvested produce

Unit II. Postharvest handling of plant material, pre-processing or raw material for packaging and further extraction of active ingredients. Methods of extraction of secondary metabolites from medicinal plants viz., Surpagandha, periwinkle, steroid bearing solanums, ashwagandhasenna, kempferia, plumbago, holostemma, aloe, safedmusli, glorioisa, coleus etc.

Unit III. Harvesting, handling and processing of different aromatic crops: Oil- bearing rose, jasmine, tuberose, mint, scented jeranium, patchouli, davanna, vetiver, eucalyptus, tulsi, sandal wood etc.

Unit IV. Procedures, machinery and equipments used for extraction of active principles. Principles and practices of different types of extraction- hydro-distillation, solvent extraction, supercritical fluid extraction etc. chromatographic characterization of active principles-TLC, GC,HPLC,MS. Quality estimation of essential oils and other extracts. Studies on flavours and fragrances from aromatic crops- pomade, enfleurage, concrete, absolute, attars etc.

Unit V. Manufacture of drugs and pharmaceuticals from natural isolate medicinal plants. Nutraceuticals and other help care agents from medicinal plants. Diversified uses of metabolites in various systems of medicine viz.,, modern, ayurveda, sidha, homeopathy and other indigenous system

Unit VI. Commercial uses of essential oils, extract and other active principles from aromatic plants in perfumery industries, toilet soaps, deodorants, body sprays, aromatherapy etc.

Practical

Familiarising and identifying different economic parts of medicinal and aromatic crops. Morphological and anatomical studies of plant organs yielding active principles. Primary processing and plant material for extraction. Detailed excercises on procedure of extraction of metabolites from medicinal plants and essential oil/oleoresin from aromatic crops. Study of solvents and procedures used in extraction of concrete and absolute. Handling of chromatographs viz., TLC, GC, HPLC,MS,LCMS for isolation and qualification of the fine chemicals present in the active principles. Physio- chemical characterization and sensory evaluation of essential oils. Storage of secondary metabolites and essential oils. Visits to R and D units of NIIST, Pappanamcode, Rajeev Gandhi Centre for Biotechnology, J.N Tropical Botanic Gardens, Synthetic chemicals, Kancor, Kerala Drugs and Phramaceuticals, Oushadhi etc.

Suggested Readings

- Chadha, K.L.(ed.). 1995. *Advances in Horticulture*. Vol II. Medicinal and aromatic Plants. Malhotra Publ. House. New Delhi.
- Handa, S.S. and Kanul, M.K.1996. *Supplement to cultivation and utilization of medicinal plants*. RRL. (CSIR). Jammu Tawi.
- Kirdhikar, K.R. and Basu, B.D.1993. *Indian Medicinal Plants*. Vol 1-4. Allahabad.
- Kurian, A. and Sankar, M.A. 2007. *Medicinal Plants*. New India Publishing Agency. New Delhi.
- Masada, Y.1986. *Analysis of essential oil by Gas chromatograph and mass spectrometry*. John Wiley & Sons.
- Sadasivam, S. and Manikkam, A.1996. *Biochemical methods*. 2nd Ed. New Age International Pvt Ltd. Bangalore and TNAU, Scientific Publishers (India). Jodhpur.
- Warier, P.K., Nambiar, V.P.K. and Ramankutty, C. 1993-1996. *Indian Medicinal Plants. A compendium*. Vol 1-5. Orient Longman Ltd. New Delhi.
- Weiss, E.A.1996. *Essential Oil Crops*. CAB International. U.K
- WHO. 1998. *Quality Control Methods for medicinal plants, Materials*. WHO.

PHT 605 HI-TECH METHODS IN STORAGE, TRANSPORTATION AND PACKAGING OF FRESH AND PROCESSED HORTICULTURAL PRODUCTS (2+1)

Objective: To educate the hi-tech processing methods in storage, transportation and packaging of fresh and processed horticultural produce.

Theory

Unit 1 Importance of storage and transportation of horticultural produce. Studies in various storage systems.Refrigeration, cooling systems and methods. Storage considerations: temperature, humidity – atmospheric composition etc.

Unit II- Effect of psychometric variables on perishable commodities.Measurement of psychometric variables.M.A and C.A storage systems.Discussion on pre – storage treatments.Methods of atmospheric modification.

Unit III- Transportation of perishable and processed commodities.Short distance transport for neighbouring markets. Methods and devices of long distance surface transport. Precautions in transporting of perishable commodities.

Unit IV- Special techniques be transporting of horticultural perishable through sea and air routes. Modern transportation systems.Future thrusts in storage and transportation of horticultural produce.

Unit V- Types of packages and their importance. Packaging design and regulations for local and export markets. Specifications and quality control in packaging. Consumer packaging and bulk packaging. Problems in packaging.Packing house operations.Selection of appropriate packages.Perspectives of packaging industry in India.

Practical

Exercises on storage of fresh fruits and vegetables. Pre – treatment for enhancing storage life of perishables. Refrigerated, C.A and M.A storage systems. Post – harvest treatments for enhancing shelf life. Measurement of psychometric variables for perishable commodities.Visits to local markets for understanding different transportation systems. Visit to sea ports/ air ports for acquainting transportation by ship/air.Methods of atmospheric modification in storage of perishables and processed products.

Laboratory studies on different packing methods for perishable and processed products. Modern packing methods for fruit juices, RTS, nectars, squashes, syrups, cans etc. special packing systems for frozen, freeze- dried and dehydrated products. Innovations in the packing of curry powders, spice powders, cashew nuts, chocolates, tea and coffee. Modifications in vaccum packing, gas filling, hermetic sealing. Visits to hi- tech packaging units of Nestle, Cadbury, spices/plantation based industries.

Suggested Readings

Kader.A.A.,Kasmire, F.R., Mitchell, F.D, 1985. *Post – harvest Technology of Horticultural Crops*.Agrl.and Natural Resources pub. USA.

Potter.N.1978. *Food Science*.AVI Pub.Co.Westport.

Sreevastava, R.P. and Sanjeevkumar. 1994. Fruit and vegetable preservation – Principles and Practices, International Book Distributing Co. Lucknow.

Wills,R.H.H., Lee, T.H., Graham.D., McGlasson, W.B and Hall, E.G.1984. *Physiology and handling of fruit and vegetables*.AVI Pub.Co.Westport.

B. MINOR COURSES

PHT 606.MICROBIAL SPOILAGE, PESTICIDE RESIDUE AND POST – HARVEST DISEASES/ DISORDERS OF FRESH & PROCESSED HORTICULTURAL PRODUCE

(2+1)

Objective: To educate the occurrence, extent of damage and contamination of fresh and processed horticulture products by microbial infections, pesticide residue problems and post harvest diseases/disorders.

Theory

Unit I- Introduction to microbial spoilage of foods, perishable raw materials and processed products. Causes of pesticide residues in fruits, vegetables, spices etc. extent of post harvest diseases and disorders in fruits and vegetables.

Unit II- Classification of foods by spoilage of micro – organisms.

- (1) Stable or non – perishable : Dry foods
- (2) Semi perishable : Potatoes, apple, garlic etc.
- (3) Perishable foods : fruits, vegetables, fish, meat etc.

Causes of food spoilage, contamination of fruits, vegetables, spices during harvesting, marketing and storage. Microbial profile and microbial load of harvested material and products. Detection of spoilage. Factors influencing growth of spoilage micro – organisms. Chemical and enzymatic changes caused by micro- organisms. Modern methods of controlling microbial spoilage.

Unit III- Significance of pesticide residues in harvested materials and processed / finished products. Use of pesticides for protection of crops from pests, diseases, nematodes etc. Hazards due to pesticide residues. Levels of pesticide residues within tolerance limits. Maximum residue limits (MRL). Analysis of pesticide residues in fruits, vegetables and spices. Estimation (Identification and Quantification) of pesticide residues. Levels of pesticide residues and their role in export of horticultural crops/products.

Unit IV- Major diseases and disorders during post harvest stages of fruits and vegetables. Organisms/ factors causing post harvest diseases/disorders.

Extent of losses due to post harvest diseases/ disorders. Control of disease/disorders.

Unit V- Recent methods in detection of microbial spoilage of horticultural crops.Laboratories for testing pesticide residues in India.Hi-tech methods in storage of harvested materials and control of diseases/disorders for trading produce in domestic and export markets.

Practical

Isolation and identification of various microorganisms causing spoilage of raw materials and finished products. Detection of microbes viz.,

Fungi :Moulds, Rhizopus, Alternaria, Fusarium

Bacteria :*Psudomonas*, *xanthomonas*, *Bacillus*, *Coryneforms*, *Sclerotinia*, *Pencillium*, *Botrytis*, *clostridium botulinum* etc.

Detection of spoilage causing organisms by plate counts.

Control measures for microbial spoilage by laboratory experiments :Maintenance of anaerobic conditionsm,Use of low temperature, Drying, Irradiation, Aseptic packaging

Identification and quantification of pesticide residue by :Spectro- photometric techniques, GLC, HPLC, GC MC, ELISA etc

Detection of organisms/ Factors causing post- harvest diseases / disorders of fruits and vegetables.

Strategies for postharvest disease control:Prevention and eradication of field infections, Heat treatment, Chemicals, Irradiation, Fungicides, Antibiotics

Suggested Readings

Agrios,G.N.1997. *Plant Pathology*.Academic Press. New York.

AOAC. 2005. *Official methods of Analysis*. 18th ed. Association of Official Analytical Chemists, Washington DC.

Codex Alimentarius Commission. 2002. *Codex Alimentarius. Pesticide Residues in food*. Vol II. Joint FAO / WHO Food Standard Programme.

Eckert, J.W. and Ratnayake. 1983. *Postharvest physiology and crop preservation*. Plenum. NewYork.

Instrumental methods for pesticide Residue Analysis. 2003. Division of Agrochemicals, IARI, New Delhi.

Pursky,D., Fuchs,Y. And Yanko, U.1983. *Plant Diseases*.

Sahota, P.P. and Khanna, P.K.2007. *Microbial food spoilage and food borne diseases*. In, *Food Laws and Standards*, ICAR short Course, held at Punjab Agricultural University, Ludhiana.

**PHT 607 ADVANCES IN FERMENTATION TECHNOLOGY WITH REFERENCE TO
FRUIT & VEGETABLE PRESERVATION (2+1)**

Objective: To facilitate deeper understanding of the latest concepts in fermentation technology with emphasis on fruit and vegetable preservation.

Theory

Unit I- Introduction, history, importance and scope of fermentation. Roles of fermentation in preservations. Different types of fermentation. General methods of fermentation.

Unit II- Detailed study on the micro – organisms (yeasts and bacteria) employed in commercial fermentation. Culturing and maintenance of bacterial and yeast. Potential strains of acetic acid bacteria, lactic acid bacteria and yeasts. Biochemical basis of alcoholic, acetic and lactic fermentation.

Unit III- Fermentation for value addition and waste management, infrastructure, equipment and machinery for fermentation. Detailed studies on wines from different varieties of grapes. Classification and characteristics of wines. Studies on cidar, perry, etc. Fermented beverages from under exploited fruits and vegetables. Latest techniques in production of vinegar and lactic acid.

Unit IV- Production of fermented beverages from fruits viz., pineapple, mango, banana, papaya, Indian gooseberry, cashew apple, oranges, sapota, mangosteen, rambutan, litchi etc. Production of fermented beverages from vegetables, viz., carrot, beet root, sweet potato, tomato, cabbage and selected major vegetables. Fermentation technology adopted in commercial breweries. Production of alcohol from fermented beverages.

Unit V- Quality characteristics of fermented products. Spoilage of fermented products. Biochemical changes affected by fermented products. Addition of flavours, aromatics and other additives in fermented beverages. Exploitation of waste material from fruit and vegetable processing units (canning, RTS, juices, squashes, wafers etc) for utilization in manufacture of fermented beverages.

Unit VI- Nutritive value of fermented products.Effects of aging and methods of storage on the quality of fermented products.An overview of the grape wineries and feni production in India. Perspectives and future thrusts in fermentation of horticulture crops.

Practical

Isolation and culture of different strains of yeasts belongs to *saccharomyces ellipsoides* and *S. Carlsbergensis*.Isolation and culture of acetic acid bacteria. Preparation of fermented products from fruits viz. wine (from different grape varieties), cider, perry, feni and from various major as well as under exploited fruits. Preparation of fermented products from vegetables, viz., carrot, beet root, knoll khol, turnip, sweet potato, cabbage, tomato and selected major/ under exploited vegetables. Acquainting latest techniques, equipment and machinery on fermentation process.analysis of alcohol, acidity, TSS, sugars etc. In fermented products.Preparation of fortified wines and flavoured fermented beverages.Isolation and characterization of spoilage causing organisms/ factors in fermented products.

Suggested Readings

Amerine *et al.* 1980. *Technology of wine making*.AVI Pub.Co., Westport.

Potter, N.1978. *Food Science*. AVI Pub.Co. Westport.

Reed, G.1999. Prescott and Dunn's Industrial Microbiology.CBS Publishers and Distributors, New Delhi.

Vine, R.P.1981.*Commercial wine making*.AVI Pub.Co.Westport.

PHT 608.TECHNOLOGY OF FOOD FLAVOURS (1+1)

Objective: To educate the recent concepts and findings in the technology of food flavours.

Theory

Unit I- Importance of food flavours in processing of horticulture crops. Characterization of food flavours. Introduction to the chemistry of flavour compounds. Natural flavourings and artificial flavourings.Precursors of flavours.An overview of the flavour industry.

Unit II- Flavours in fruits and vegetables. Pathways of fruit flavour formation. Pathways of vegetable flavour formation.Location of flavour in plant.Environmental effects on flavour development. Influence of maturity on flavour development. Effects of post harvest storage condition on flavour development. Fruit aroma and vegetable aroma compounds.

Unit III- Changes in food flavour after processing. Non- enzymatic browning. (1) formation of flavour compounds viz., Carbonyls, Pyrazines, Pyrroles, Nitrogen Heterocyclics, Sulfur heterocyclics, flavours from lipids. (2) flavours formed via Fermentation viz., Esters, Acids, Carbonyls, Alcohols, Terpenes, Lactones etc.

Unit IV- Flavouring materials of natural origin.Sources of natural flavouring materials.Herbs and spices.Fruit juices and flavour. Flavour of onion, garlic and other vegetables. Flavour of Vanilla, Cocoa, Ccoffee, Tea etc.

Unit V- Synthetic flavouring materials. Imitation flavourings matching natural flavours.Classification of flavourants by Molecular structure.Sensory characters of synthetics.Consumer attitudes toward synthetic chemicals.

Unit VI- Flavourpotentiators. Natural occurring ones. Source of commercial potentiators- Monosodium Glutamate and other potentiators. Sensory properties of potentiators (taste, aroma, synergism etc.)

UNIT VII- Application of flavourings– Meat products, bakery Products, Snack Foods, Sugar and Chocolate confectionery, soft drinks etc.

Practical

Isolation and identification of flavours in fruits and vegetables. Laboratory studies on the effects of post harvest storageconditions on flavour development. Detection of odd flavours in raw materials and processed products.Isolation and identification of flavours and aromatics from herbs and spices. Laboratory experiments on the application of natural/ synthetic flavours in processed products viz., juices, RTS, Nectar, Cordial, Squashes,Syrups, Preserves, Candies, Fermented products and subsidiary products viz, Fruit butters, Toffee, Cheese, Halwa etc.

Suggested Readings

AOAC. 1997. *Official methods of analysis*. Association of official analytical chemists. Washington DC.

Ashwani.K.G., Rajinder, K and Satwinder, S.M.2007 *Post harvest management and value addition*. Daya publishing house new Delhi.

Athey, D and Dennis, C.1991. *Vegetable processing*. Glasgow. Blackie

NIN, 2005. *Food colours, flavours and additives*. Technology handbook.2005.National institute of industrial research, New Delhi.

NIN. 2005. *Food flavours: technology hand book 2004*. National institute of industrial research, New Delhi.

Jellinck, G 1985. *Sensory evaluation of food*. Ellis Horwood., England

Rananna, S.1977. *Manual of analysis of fruit and vegetable products*, TataMcGraw Hill Publishing Co., New Delhi.

UG Syllabus

Hort. 3207. Post harvest management and processing of horticultural crops (2+1)

Theory

- 1,2. State of Indian fruit and vegetable processing industry- Importance of post harvest management of fruits, vegetables and other horticultural produce, problems & prospects
2. Fruits and vegetables their chemical composition
3. Physiology of maturity, ripening and senescence in fruits and vegetables
4. Post harvest losses - Pre and post harvest factors causing loss and spoilage of fruits and vegetables
- 4,5- Post harvest management techniques for fruits and vegetables- Pre-cooling- methods- grading and sorting- other operations- washing-sanitization- heat treatments- waxing- curing etc.
- 6,7- Storage system- ambient, low temperature, modified and controlled atmosphere storage systems- storage disorders
- 8,9- Packaging technology - wholesale and retail packaging - packaging materials – advantages and disadvantages- consumer packaging.
- 10- Government policies, regulations and specifications for fresh and processed products- Marketing systems- Export promotion agencies and their role in export of fresh and processed products.
- 11,12- General principles and methods of preservation. Recent advances in food preservation techniques.
- 13- Principles of preservation by removal of water - pretreatments – blanching- sun drying, dehydration –methods.
- 14,15-Principles of preservation by application of heat (Thermal processing) -pasteurization – sterilization- Steps in canning and spoilage of canned products.
- 16,17- Principles of preservation by ionizing radiations, Principles of preservation by chemical methods- Role of sugar, brine, acid and other chemical, preservatives, other food additives.
- 18 Principles of preservation by fermentation- Alcoholic, acetic and lactic fermentation processes.
- 19,20- Post harvest technology of coconut
- 21- Post harvest technology of Arecanut.
- 22- Post harvest technology of Oil palm
- 23-24 Post harvest technology of Rubber
- 25- Post harvest technology of Tea
- 26- Post harvest technology of Coffee
- 27, 28- Post harvest technology of Cocoa

29. Postharvest technology of spices- general aspects
30. Postharvest technology of pepper
31. Postharvest technology of cardamom
32. Postharvest technology of ginger, turmeric & chilies
33. Postharvest technology of Tree spices
34. Postharvest technology of essential oil yielding crops
35. Postharvest technology of cut flowers
36. Industrial waste utilization

Practicals

General guidelines for setting up of a small scale fruit and vegetable processing unit- FSSAI standards- Analytical methods in quality evaluation of raw material and product quality- TSS, Acidity, sugars, ascorbic acid etc. Preparation of important fruit and vegetable products- jams, jellies, pickles, candies, fermented and unfermented beverages, sauces- Commercial production of processed products- Preparation of coconut, pepper and ginger products- Estimation of spice essential oils- Solvent extraction of spice oleoresins - Familiarization with different processed products from spices and plantation crops- Commercial grades of plantation and spices- Visit to processing units of horticultural crops.

Suggested Readings

- Srivastava, R.P and Sanjeev Kumar.2007. Fruit and vegetable preservation: Principles and Practices. International Book Distributing Company, Lucknow.474.
- John, P.J. 2008. A hand book on Post Harvest management of Fruits and Vegetables. Daya Publishing House. Delhi.147.
- Sharma, S.K.2010. Postharvest management and processing of fruits and vegetables- Instant Notes. New India Publishing Agency. New Delhi.390.
- Saraswathy, S., Preeti, J.L., Balasubramanyan, S., Suresh, J., Revathy, N. and Natarajan, S. 2008. *Postharvest management of horticultural crops*. AGRIBIOS (India).
- Sudheer, K.P. & Indira ,V 2007. *PostHarvest Technology of Horticultural Crops*. New India. Publ. Agency.
- Mitra, S. K. 1997. Postharvest Physiology and Storage of Tropical Fruits. CAB International, UK.
- Panastico, B.M 1975. Postharvest physiology, handling and utilization of Tropical and sub-tropical Fruits and Vegetables. The AVI Publishing Company, INC
- Purseglove, J.W. et al 1981. Spices, Longman, New York (2 vols).
- Ranganna, S. 1977. Manual of analysis of fruits and vegetables products. Tata Mc. Graw Hill Publishing Company, New Delhi.
- Roger,C Griffin, J.R and Stanley Sacharow 1972. Principles of package development. The AVI Publishing Company INC, Westport, USA.

EXPERIENTIAL LEARNING PROGRAMME [B.Sc. Hons (Ag)] Module : Elph.4201
COMMERCIAL PROCESSING AND VALUE ADDITION OF
HORTICULTURAL CROPS (0+10)

Objective : To impart latest knowledge and skills on various aspects of commercial processing of horticultural crops and developing value added products with good market potential

Unit 1. Market survey to explore the marketing potential of processed horticultural products : To recognise various horticultural products in the market, assess consumer demand, identify the ingredients and the novel technology involved in product development, packaging and labelling requirements of different products

Unit 2. Processing & Value Addition of Spices & Plantation Crops: Commercial production of spice products - whole dry spices, spice powders, curry powders, oils and oleoresins. Fresh spice products -paste, pickle, candy, essence, sauce etc.

Commercial processing of plantation crop products :

Tender coconut products – (packed/ bottled tender coconut water, coconut shake, coconut jam, coconut preserve etc.)

Coconut vinegar, coconut chips, desiccated coconut, coconut inflorescence sap (preserved), home-made chocolates, jelly from nutmeg rind etc.

Unit 3. Processing & Value Addition of Vegetables - Commercial production of pickles, sauces, ketchups, chips/wafers, “kondattoms”, other dried/ dehydrated products, puree, soups, nutritional salads etc.

Unit 4. Processing and Value Addition of fruits -Commercial preparation of RTS beverages, nectars, cordials, squashes, crushes, syrups, preserves, candies, fruit punch, fruit shakes, jams, jellies, marmalade, cheese, halwa, fruit bar, toffee, osmo-dehydrated products, wines etc.

Unit 5. Waste utilization in processing industry -By-products from wastes of processing industry – seed flour from jack fruit, mango kernel, jack fruit rind, dehydrated products from fruit peel etc.

Unit 6. Guidelines for commercial ventures, Quality Control in Food Processing Industry. Set-up of processing units with emphasis on site selection, layout, procurement of equipment/machinery. Industrial sanctions, acquisition of FPO licence, FPO specifications for processed products etc. Bulk preservation of pulp, juice etc. Personnel required in processing unit, maintenance of registers, unit operations etc.

Quality Control :- Raw material control, process control, finished product control, sensory evaluation, packaging, containers and labels for products, regulations for domestic and export markets. GAP, GMP, HACCP and other quality standards.

Unit 7. Visit to Industrial Units, attachment to the units & developing entrepreneurial skills. Visits to fruit and vegetable processing units, coconut processing unit, cocoa processing unit, cashew processing factories, areca-nut processing unit, rubber processing unit, spices processing units etc. and exposure to commercial/ hi-tech processing. Visits to packaging units, Quality control labs, Training centres of Coconut Development Board, Spices Board etc.

Unit 8. Preparation of proposals for commercial ventures and production economics. Project preparation and appraisal, cost- benefit ratio, NPV, IRR, and PBP. Purchase & Accounting/Production /packing & labelling storage costing& marketing.