

**School of Natural Product Studies**  
**Department of Pharmaceutical Technology**  
**Jadavpur University**  
**Kolkata-700032**

**Course Name: Certificate course on Herbal medicine**

**Scope:** During the past decade Herbal medicines and natural products have taken a pivotal role in drug discovery and drug development. Owing to the diverse biological activities and therapeutic potential of herbal medicines nearly every civilization has accumulated experience and knowledge of their use. Utilization of molecular biology and combinatorial chemistry has allowed to scientifically validate the traditional claims of natural products as well as assure its safe and efficacious utilization.

Some important factors of this course have been listed below:

- Promotion and development of Ethnopharmacology, medicinal plants, traditional medicine and other natural products through dissemination of knowledge for Globalizing local knowledge and localizing global technologies
- Promotion and development of new natural products utilizing the ethnopharmacological & traditional knowledge and to understand the global need of the ancient medicinal systems such as, Ayurveda, Unani, Siddha and others
- To bridge the gap between industry and academia with modern tools and hyphenated instruments.
- Screening & Evaluation of natural products
- Value addition to natural products through value added herbal drug delivery systems
- Quality control and standardization of natural products formulation
- High throughput screening for the lead finding in natural products.
- To understand the nature of synergy and polypharmacology exist in the natural medicinal products with the knowledge of system biology
- To find the cure of different ailments including neglected diseases utilizing the knowledge of ethnopharmacology and natural product research.
- To establish the future of ancient system of medicines utilizing multidisciplinary approaches in health sciences
- To promote national and international cooperation among researchers in interdisciplinary, multidisciplinary and trans-disciplinary aspects for development of ethnopharmacology and natural product studies
- To encourage the research activities in the direction of traditional medicine inspired drug discovery and development of potentially active new chemical entities from medicinal plants

**Necessary Qualification:** Diploma, Degree or MS in Pharmacy, BSc. and MSc. from any College approved by the regulatory authority.

**Duration of Course:** 6 months

**Course fee – Rs. 30,208/-**

**Application fee – Rs. 100/-**

**Subject & Syllabus:**

**Subject 1**            Quality Evaluation of Herbal Medicines: Challenges and Opportunities  
(**Theory**)

**Subject 2**            Extraction and Other Downstream Procedures for Evaluation of Herbal  
Drugs (**Theory**)

**Subject 3**            Chromatographic Analysis of Herbal Drugs (**Theory**)

**Subject 4**            Extraction and other Downstream Procedures for Evaluation of Herbal  
Drugs (**Practical**)

## Detailed syllabus

**Subject 1: Quality Evaluation of Herbal Medicines: Challenges and Opportunities (Theory)**

**Credit points: 4**

- a) Factors Affecting the Quality of Herbs Ingredients –
- Authentication and Reproducibility of Herbal – Identification of macroscopical and microscopical characteristics, comparison with authentic material/ herbs, refer the herbs by their binomial Latin names of genus and species
  - Inter/Intra Species Variation in Plants – variation of plants, variation of primary and secondary metabolites
  - Environmental Factors – factors responsible for plant growth and quality, solar radiation, soil nutrients, environmental stress (water, drought, salinity, chemical, temperature, ecological factors, seasonal variation)
  - Geographical Location - locations and environmental conditions effect on biosynthesis of plant metabolites, productive climatic conditions, effect of different locations on the pharmacological activity of the plant
  - Plant Parts Used – adulteration, metabolites present in different plant parts, therapeutic constituents present in plant part,
  - Time of Harvesting - optimum time for harvesting, importance of harvesting on plant metabolites
  - Post Harvesting Factors - storage and transportation of herbs
  - Contaminants in Herbal Ingredients - environmental contaminants, pesticides, fumigants, and other toxic metals,
  - Chemical Variation in Medicinal Plants – effect of environmental factors on chemical composition, examination of quality of herbal medicine from the perspective of chemical constituent.
- b) Adulterations of Herbal Drugs –
- Various Means of Adulterations in Herbal Medicine - substitution with inferior commercial varieties, adulteration by artificially manufactured substitutes, substitution by exhausted drugs, substitution by superficially similar but cheaper natural substances, adulteration by addition of worthless heavy materials, addition of synthetic principles, adulteration with inferior drugs, harmful adulterants
  - Reasons of Adulteration - confusion in vernacular names, lack of knowledge about authentic sources, similarity in morphology, similarity in color, careless collections, other unknown reasons
- c) Deterioration of Herbal Drugs –
- Light, Moisture, Temperature, Airic Oxidation, Bacteria and Molds, Mites and Nematode Worms, Insects and Moths, Coleoptera or Beetles, Control Measures for Deterioration
- d) Substitution of Herbs –

Substitution of the plant Species Belonging to the Same Family, Substitution of Different plant Species, Substitution of Different Parts of the Same Plant  
Substitution Due to Same Action – substitution of plant species as per their same pharmacological activities

e) Counterfeiting of Herbal Medicine

Types of Counterfeit Drugs and Their Consequences - counterfeit drugs containing the same dose of the active ingredient, mislabeled medications, counterfeit drugs containing an incorrect dose of the active ingredient, counterfeit drugs that do not contain the active ingredient, counterfeit drugs containing a potentially harmful substance, counterfeit drugs containing an unlisted active ingredient, genuine medicines marketed for incorrect or recreational use

Preventive Measures – developing technology of anticounterfeiting strategy

Methods of Detection - analysis of bioactive marker compounds by thin-layer chromatography (TLC), LC–MS, gas chromatography, HPLC, HPTLC, identification of holograms and security print, electronic tracking systems

f) Collection of Herbs –

Methods of Bark Collection - felling method, uprooting method, coppicing method

Illustrative Examples of collection of herbs

Good Agricultural Practices – Developing standard operating procedures for cultivation, environmental condition for ideal cultivation of plants

g) Identification and Authentication of Herbs –

Botanical identity- scientific name (genus, species, subspecies/variety, author, and family), the local and English name or common name, cultivar name, ecotype, and the chemotype or phenotype

commercially available cultivars - name of the cultivar and of the supplier

landraces collected, propagated, disseminated and grown in a specific region -

locally named line, origin of the source seeds, plants, or propagation materials.

identification of adulterants from genuine medicinal herbs

standardization of herbal raw drugs - authorization of data on raw plant drugs, botanical authentication, microscopic and molecular examination, identification of the chemical composition by various chromatographic techniques

sensory evaluation parameters - shape, size, color, texture, odor, and taste

microscopy - microscopic inspection of the powdered herbal drug.

standardization of herbal drugs - chromatography, spectrophotometry, electrophoresis, polarography, molecular biomarkers

h) Taxonomy of Herbs –

Nomenclature of Medicinal Plants - rules involving in plant nomenclature, International Code of nomenclature for cultivated plants,

Author Names and Synonyms - use of author names in plant nomenclature,

Classification Systems - plant scientific categorization framework,

i) Herbarium Documentation for Medicinal Herbs –

Voucher Specimen – Preparation of voucher specimen, methodology, standard operating procedure for preparation of voucher specimen  
Preparation of Herbarium - collection of plant material, pressing and drying, labeling of specimen, storage of specimens

**Subject 2: Extraction and Other Downstream Procedures for Evaluation of Herbal Drugs (Theory)**

**Credit points: 4**

- a) Basic Principles and Rationale – bioactivity-guided isolation process, basic principle involving in plant material extraction, extraction process parameters, selection of appropriate extraction technology
- b) Factors Affecting Extraction of Herbal Drugs
  - Types of Extracts - aqueous extracts (Decoction, Infusion, Digestion, Tinctures, Liquid extracts, Soft extracts, Dry extracts)
  - Raw Materials – particle size, shape and porosity of solid samples, size reduction procedure, drying of raw material, storage
  - Choice of Solvent – several aspects for selecting solvents such as solvent power (selectivity), boiling temperature, reactivity, viscosity, safety, cost, vapor pressure, and recovery
  - Conditions for Extraction – size of raw materials, flow of solvents, agitation
  - Selection, Collection, and Identification of Plant Material - selection of plants (based on ethnopharmacological, chemotaxonomic, geographical, or compound structural bases, environmental factors, parts of plant selected for extraction, preservation of herbarium samples, authentication and identification of plant
  - Drying of the Crude Drugs – Methods of drying, air drying, microwave heating, oven drying, freeze drying
  - Comminution and Classification – importance of size reduction of plant material, different types of fractions, comminution of different plant parts including medicinal leaves and herbs, roots and barks, seeds and fruits
- c) Methods of Extraction
  - Factors Affecting the Choice of Extraction Process - nature of the crude drug, stability profile of the crude drug, cost, nature of the solvent, method used for concentration of the extract
  - Maceration, Digestion, and Remaceration – methodology, advantages and disadvantages, percolation and and Repercolation factors affecting percolation extraction
  - Infusion and Decoction - methodology
  - Vortical or Turbo Extraction - methodology
  - Ultrasound Extraction – methodology, advantages
  - Extraction by Electrical Energy - methodology

- Countercurrent Extraction - continuous countercurrent extraction, relative countercurrent extraction
- Hot Continuous Extraction—Soxhlation – methodology, advantages and disadvantages, high-pressure soxhlet extraction, automated soxhlet extraction, ultrasound-assisted soxhlet extraction, microwave-assisted soxhlet extraction
- Extraction of Essential Oil – distillation (hydro diffusion, water distillation, water and steam distillation, direct steam distillation, cohobation)
- Microwave Extraction – principle, microwave-assisted subcritical and super critical fluid extraction, microwave-assisted enzymatic extraction
- Supercritical Fluid Extraction – methodology
- Pressurized Liquid Extraction - methodology
- General Protocols for Extraction of Phytoconstituents
- d) Effect of Solvent, Solvent Mixtures, and Solution on Extraction
- Solvents Used for Extractions – selection of solvent for extraction, solubility, quality of solvent
- Extraction Enhancement by Emerging Extraction Solvents – ionic liquids and other enhancements by eutectic solvents, multiphase solvents, nonionic surfactants
- Properties of Solutions - colligative properties, constitutive properties
- Types of Solutions - azeotropic mixtures, solubility of active constituents, the phase rule, solubility expressions, solvent–solute interactions
- Classification of the Solvents – polar solvents, semipolar solvents, nonpolar solvents
- Influence of Solvents – influence of solvents on plant extract
- Combined Effect of pH and Solvents, Examples of Effects of Solvents on the Extraction
- e) Characteristics of Phytoconstituents –  
Polarity, pH, Thermostability
- f) Interfering Compounds in Extraction of Desired Phytoconstituents -  
Compounds such as lipids, colors and pigments, plasticizers, water soluble polysaccharides and other carbohydrate polymers interfere with the extract and phytoconstituent
- g) Extraction Methods for Specific Phytochemical Groups  
Methods of extraction for extracting specific phytoconstituent such as, alkaloids, carotenoids, fixed oils, fats, waxes, glycosides, phenolic compounds, proteins, polysaccharides
- h) Treatment of Drug Residue After Extraction–Downstream Processing
- Sanitization of Extracts and Elimination of Solvents
- Removal of Solvents – vaporization, concentration of solvents, rotary vacuum evaporator, tube vaporizers, falling film vaporizer
- Freeze Drying – methodology involving freeze drying, basic principle and other uses, advantages, category of freeze dryer
- Reverse Osmosis
- Particle Size Reduction

### Subject 3: Chromatographic Analysis of Herbal Drugs (Theory)

#### Credit points: 4

- a) High-Performance Thin-Layer Chromatography (HPTLC)  
Advantages of HPTLC – flexibility, choice of detection, cost and time efficiency, user friendliness and result presentation  
Main Features of HPTLC – Basic principle, difference between TLC and HPTLC
- b) Methodology in HPTLC  
Instrumentation – LINOMAT, automatic TLC sampler,  
Selection of Mobile Phase – factors involving for mobile phase selection  
Preparation of HPTLC Plate – methodology  
Sample Preparation and Application - sample application in HPTLC, sample application in the form of bands or rectangles, development of plate, processes in the developing chamber, important aspects to be considered in the development process, influence of temperature on TLC analysis, influence of coating materials and plates on the performance of TLC  
Retardation Factor – calculation of retardation factor, reproducibility of  $R_f$  factor  
Detection and Densitometric Scanning - derivatization and detection, opto-mechanical scanning, electronic scanning, laser scanning, detection methods used in scanning densitometry (single-beam mode, double-beam mode, single-beam dual-wavelength mode), type of scanning mechanisms (slit scanning/linear scan, meander/flying-spot scanning, in situ quantitative evaluation (baseline compensation, computer-controlled multiwavelength evaluation, photodiode array scanning, parameters of the scanner affecting the performance of detection (slit width of the monochromator, macro and microparameters for the slit dimensions)
- c) HPTLC Validation Procedure  
Selectivity, Sensitivity, Precision, Accuracy, Ruggedness, Limit of Detection, Stability
- d) Use of HPTLC for Standardization of Herbs and Extracts  
Simultaneous Measurement of Andrographolide and Wedelolactone  
Quantification of Eugenol, Luteoline, Ursolic Acid, and Oleanolic Acid in Black and Green Varieties of *Ocimum sanctum*  
Estimation of Phyllanthin and Hypophyllanthin  
Determination of Curcumin  
Determination of Podophyllotoxin  
Determination of Hyperforin in *Hypericum perforatum*  
Determination of Corosolic Acid  
Determination of Hecogenin from *Agave Americana*  
Quantification of Valerenic Acid in *Valeriana Jatamansi* and *Valeriana officinalis*  
Analysis of Quercetin, Rutin, and Coumaric Acid in Flowers of Rhododendron  
Determination of Lycorine in Amaryllidaceae Plant Extracts  
Quantification of Fraxin in *Fraxinus excelsior*  
Quantification of Hypericin in Valena N Extract with St. John's Wort  
Quantification of Commercial Ginseng Medicine

- Determination of 6-Gingerol in *Zingiber officinale*
- Determination of Gallic Acid in “Triphala”
- Determination Glycyrrhizin in *Glycyrrhiza glabra*
- Determination of Taraxerol from *Coccinia grandis*
- Determination of Betulinic Acid in *Nelumbo nucifera*
- Determination of Taraxerol in *Clitoria ternatea*
- e) Case Studies of HPTLC With Some Specific Medicinal Plants

**Subject 4:** Extraction and other Downstream Procedures for Evaluation of Herbal Drugs  
(Practical)

**Credit points: 3**

- a) Selection of Raw Materials - selection of plants (based on ethnopharmacological, chemotaxonomic, geographical, or compound structural bases, environmental factors, parts of plant selected for extraction.
- b) Collection, Identification Authentication of Plant Materials - preservation of herbarium samples, authentication and identification of plant samples
- c) Drying of plant Materials by using suitable methods - air drying, microwave heating, oven drying, freeze drying
- d) Size reduction, comminution and storage of Raw Materials – methodology of size reduction of raw materials (grinding, cutting, chopping), comminution of different plant parts including medicinal leaves, herbs, roots, barks, stems, flowers seeds, fruits, storage conditions of raw materials
- e) Selection of solvents – selection of solvent for extraction on the basis of solvent power (selectivity), boiling temperature, reactivity, viscosity, safety, cost, vapor pressure, and recovery; classification of the Solvents (polar solvents, semipolar solvents, nonpolar solvents)
- f) Methods of Extraction - Maceration, Digestion, Remaceration, Infusion and Decoction, Vortical or Turbo Extraction, Ultrasound Extraction, Extraction by Electrical Energy, Countercurrent Extraction, Soxhlation, Extraction of Essential Oil, Microwave Extraction, Supercritical Fluid Extraction, Pressurized Liquid Extraction, Extraction of Phytoconstituents
- g) Extraction Methods for Specific Phytochemical Groups - Methods of extraction for extracting specific phytoconstituent such as, alkaloids, carotenoids, fixed oils, fats, waxes, glycosides, phenolic compounds, proteins, polysaccharides
- h) Treatment of Drug Residue After Extraction and removal of solvents–Downstream Processing; vaporization, concentration of solvents, rotary vacuum evaporator, tube vaporizers, falling film vaporizer, Freeze Dryer
- i) Characteristics of Phytoconstituents – Characterize phytoconstituent by Polarity, pH, Thermostability
- j) Qualitative phytochemical analysis; evaluation of total phenolic and total flavonoid content of plant extract



- k) TLC, HPTLC, RP-HPLC analysis of plant extract – mobile phase selection based on polarity, selection of standard phytochemical, HPTLC fingerprinting, quantity and quality evaluation of plant extract

**For Further details  
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