

Good agricultural and collection practices of medicinal plants

for supply of quality raw herbal drug

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To comply the demand of quality phytomedicines, well defined standard raw herbal drug with specific production strategies are required. Good agricultural and collection practices are meant to provide defined and reproducible production conditions for collector and cultivator of medicinal herbs. The introduction of comprehensive production protocols (way-bills) could be expected to contribute to the production of quality raw herbal drug. In India, 70 to 80 % of the raw herbal drugs were collected from wild even though commercially important medicinal herb cultivation gaining importance. In this context sustainable collection of medicinal herbs showed comparable importance as cultivation. This article discusses how good agricultural and collection practices guidelines and specification outlining medicinal herbs growing and handling conditions produce quality herbal drugs and why good agricultural and collection practices need to be an intrinsic part of quality assurance system for plant based medicines.

Key words: Agriculture, Herbal drug, Phytomedicines, Production, Quality assurance

MEDICINAL plants have occupied an important position in the socio-cultural, spiritual and medicinal arena of rural and tribal lives of India. According WHO estimates, about 80% of the world's population depends mainly on traditional health care system for their primary health care. The modern system of medicine also uses many of the medicinal plants for drug development. Medicinal plants sector needs to assure the continuous supply of quality raw material, most likely produced by following the standard procedures uncontaminated by either synthetic pesticides or by genetically modified organisms and certified by accredited agencies. Good Agricultural Practices are 'practices that address environmental, economic and social sustainability for on-farm processes, and result in safe and quality food and non-food agricultural products. The main

objectives of good agricultural practices is ensuring safety and quality of produce in the food chain, capturing new market advantages by modifying supply chain governance and improving natural resources use, workers health and working conditions, creating new market opportunities for farmers and exporters in developing countries. Even though medicinal plants cultivation is gaining momentum, 70% of the medicinal plants are collected from the wild habitats. Harvest of medicinal plants for subsistence or trade requires access and management of natural resources, and knowledge of product and processes. Good collection practices needs to be developed to help collectors and processors to produce and maintain quality of medicinal plants material, besides its sustainable conservation.

However, this requires a holistic

and strategic plan from sustainable utilization to economic development, conservation of vital biodiversity, crop diversification, quality raw material and marketing etc. Besides this, increase in resource use efficiencies 'more from less', management of emerging biotic and abiotic stresses, quality assurance through accredited laboratories, and development of scientific infrastructures for harvest and post-harvest operations are need to be addressed. Collection in wild habitats may present special problems, especially with regard to confusion with similar plants, environmental damage, lack of control and poorly qualified personnel. However, these considerations should be used as a basis for the establishment of such an appropriate quality assurance system. The main aim is to ensure consumer safety by establishing appropriate quality standards for medicinal

plants/herbal substances. Especially important aspect is handled with care so that medicinal plants/herbal substances are not adversely affected during collection, cultivation, processing and storage.

Genesis of good agriculture and collection practices in medicinal plants

Good agricultural and collection practices for medicinal plants (GACP for short) are a set of guidelines developed in 2003 by the World Health Organization (WHO), aimed at improving the quality of medicinal plant material being used in herbal medicines in the market. The main objectives of the good agricultural and collection practices guidelines, as stated by the WHO, are as follows:

To contribute to the quality assurance of medicinal plant materials used as the source for herbal medicines to improve the quality, safety and efficacy of finished herbal products.

To guide the formulation of national or regional good agricultural and collection practices guidelines, and good agricultural and collection practices monographs for medicinal plants and related standard operating procedures.

And to encourage and support the sustainable cultivation and collection of medicinal plants of good quality in ways that respect and support the conservation of medicinal plants and the environment in general.

But, these guidelines were not applicable with same principles under diverse environmental and social conditions throughout the world and hence, it was suggested that country or region-specific standards can be developed that are targeted specifically towards the farmers and collectors of that area. In India, the National Medicinal Plants Board, in collaboration with the WHO Country Office for India, developed a set of guidelines and standards for Good Agricultural Practices and Good Field Collection Practices in 2009. Recently, the Directorate of Medicinal and Aromatic Plants Research started work on development of training module and facilitation guide for good agricultural and collection practices

with the help of National Medicinal Plant Board. These guidelines and standards targeted specifically towards medicinal plant producers in the Indian sub-continent. Besides India, region specific Good Agricultural Practices were also developed by China (2002), European Union (2002) and Japan (2003). Other guidelines relevant medicinal plants are 'Codex Alimentarius Code of Practices' developed by the Joint FAO/WHO Codex Alimentarius Commission.

Good agriculture and collection practices for medicinal plants

Realistic quality control of medicinal plants involves both good agricultural collection practices and good manufacturing practices and involves entire process from raw materials to marketable products (Table 1). Thus, adoption of proposed way-bill for medicinal plants (including crud drug) as part

Table 1. Quality determining factors in production of medicinal plants

Quality variables	Possible causal agent
Genotype	Species, Cultivar
Development	Growth, Flowering
Morphogenesis	Plant organ, tissue
Environment	Soil fertility, light, temperature, competition
Processing	Drying, distillation, extraction
Contamination	Physical object, pesticides, heavy metals and mycotoxins

of whole production system could be a first step in ensuring the supply of high quality, safe and efficient phytomedicines. So, growers and collectors of medicinal plant materials need to be aware that several factors affect the quality of raw herbal drug (Table 2).

Good collection practices should ensure the long-term survival of wild populations and their associated habitats. Management plans for collection should provide a framework for setting sustainable harvest levels and describe appropriate collection practices that are suitable for each medicinal plant species and plant parts used (roots, leaves, fruits etc). Collection of medicinal plants raises a number of complex environmental and social issues that must be addressed locally on a case-by-case basis. It is acknowledged that these issues vary widely from region to region and cannot be fully covered by a particular guideline. After collection, the raw medicinal plant materials may be subjected to appropriate preliminary processing, including elimination of undesirable materials and contaminants, washing (to remove excess soil), sorting and cutting. If more than one medicinal plant part is to be collected, the different plant species or plant materials should be gathered separately and transported in separate containers. Cross-contamination should be avoided at all times.

The collection of medicinal plants

Table 2. Quality monitoring in raw herbal drug production

Production steps	Quality control measures
Good agricultural practices	
Collection and cultivation of medicinal plants	• Correct identification of plant material • Site selection for collection and cultivation • Plant history and growth environment • Discernment of plant sagacity
Raw material handling	• Cleaning of plant tissue • Maintenance of phytosanitary status • Analysis of tissue physical properties
Primary processing	• Maintenance of chemical and physical properties • Maintenance of phytosanitary status • Evaluation of suitability for prospective use
Secondary processing	• Maintenance of chemical and physical properties • Maintenance of phytosanitary status • Preliminary preparation for tissue applications
Storage	• Maintenance of chemical and physical properties • Maintenance of phytosanitary status
Good manufacturing practices	Product development

from wild populations can give rise to additional concerns related to global, regional or local over-harvesting, and protection of endangered species. The impact of collection on the environment and ecological processes, and the welfare of local communities should be considered. Medicinal plants collected from the wild population may be contaminated by other species or plant parts through misidentification, accidental contamination or intentional adulteration, all of which may have unsafe consequences. In this regards, good agricultural practices were recognized as an important tool for ensuring the safety and quality of raw herbal drug through a steady, affordable and sustainable supply of medicinal plant materials of good quality. It is also a fact that certain herbal medicines are no longer reliable since the large demand for large quantities of quality supply could not be satisfied by limited plantations in those regions. A comprehensive recommendation of agricultural practice: from seedling, planting, fertilizing, harvesting, storage to distribution, can be offered as a compromise. There is good prospect of an excellent supply of quality herbal products with uniformity, if good agricultural practice could be practised and enforced. The good agricultural practice described general principles and provided technical details (Table 3) for cultivation of medicinal plants with quality control measures, where applicable.

Quality assurance in medicinal plants

Although herbal medicines are widely used for the prevention,

Table 3. Good agricultural practices for medicinal plants from

Authentic planting materials
• Botanical identity
• Voucher botanical specimen
• Seeds and propagation materials
Cultural connections
• Site selection
• Ecological environment and social impact
• Climate
• Soil
• Irrigation and drainage
• Plant maintenance and protection
• Harvest and storage

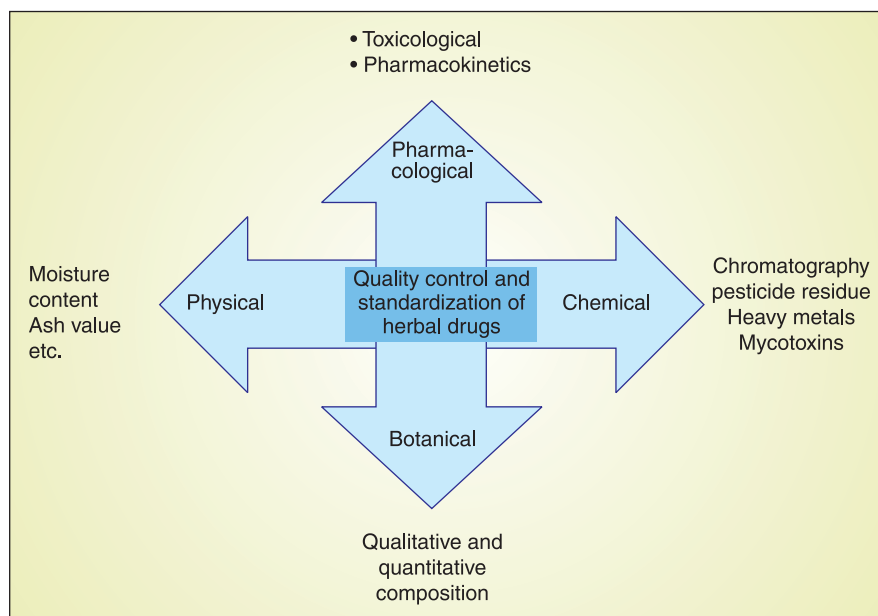


Fig. 1. Standardization and quality evaluation of raw herbal drugs

diagnosis, treatment and management of disease, one of the impediments in its acceptance is the lack of standard quality control profile. The quality of herbal medicine has implications in efficacy and safety. Quality issues of herbal medicines can be classified into two categories: external and internal.

The external issues are included contamination (e.g. toxic metals, pesticides residues and microbes), adulteration and misidentification. Internal issues that affecting the quality of herbal medicines is the complexity and non-uniformity of the ingredients in herbal medicines.

A schematic representation of factors affecting the herbal drug standardization in quality and safety is shown in Fig. 1. The external contaminants accumulated during the cultivation, storage and processing of herbs and sometimes had adverse effects on consumer health. Environmental factors including soil, altitude, seasonal variation in temperature, atmospheric humidity, length of daylight, rainfall pattern, etc., may affect the concentration of active ingredient (a.i.) in herbal drugs and thus affect the internal quality. The processing of raw materials which involve heating or boiling, can further alter the pharmacological activity of the a.i. external quality issues are complex, internal ones, however, can be even more

challenging.

Medicinal herbs are categorized either as food (dietary supplements) or medicinal products, depending on their national legislation and definitions and varied between and within countries. Virtually all herbal products sold in the United States of America were treated as dietary supplements and therefore as foods and are subject to less stringent regulatory control compared to conventional medicines. A regulatory framework for herbal medicines can provide greater assurance to consumers. To ensure both safety and efficacy of herbal medicines, implementation of good agricultural and collection practice, good plant authentication and identification practice, good manufacturing practice before and during the manufacturing process, and good laboratory practice in analysis are necessary. Establishment of harmonized multilaboratory-validated analytical methods and transparency in the supply (value) chain through vendor audits are additional requirements in quality assurance. Through the use of modern analytical methods with standard operating procedures, and pharmaceutical techniques, the standard herbal products can be manufactured from the standard herbal extracts.

Other than the good agricultural

and collection practice for medicinal plants by WHO 2003, in 2007, a new guideline 'WHO guidelines for assessing quality of herbal medicines with reference to contaminants and residues' was formulated. The European Union, China and Japan developed regional and national guidelines for good agricultural and collection practices for medicinal plants which limit the irrigation water and soil in terms of pesticide residues and heavy metals during the cultivation and propagation of medicinal herbs. Indian Pharmacopoeia Commission, an autonomous Institution of the Ministry of Health and Family Welfare, Government of India, published official documents for improving quality of herbal medicines by way of adding new and updating existing monographs in the form of IP which primarily focus on the standardized raw material. However, scientific evidence supporting the rational limits of the residues of the external contaminants is unavailable except few cases for heavy metals and aflatoxins. Currently achievement in quality control of herbal medicine is regional and partial. To achieve the overall improvement of quality, efforts were made to deepen methodological researches and enhance harmonize regulatory limit in herbal medicines. The governmental organizations assume responsibility to provide active guidance and effective regulation.

Role good agricultural and collection practice in sustainable production and income generation

Improvement of farm ecology through good management of input resources, improved cost management and good practices for integrated pest and disease management, improved productivity through the introduction of efficient operations management that eventually results in higher production thereby higher income, enhanced safety through the

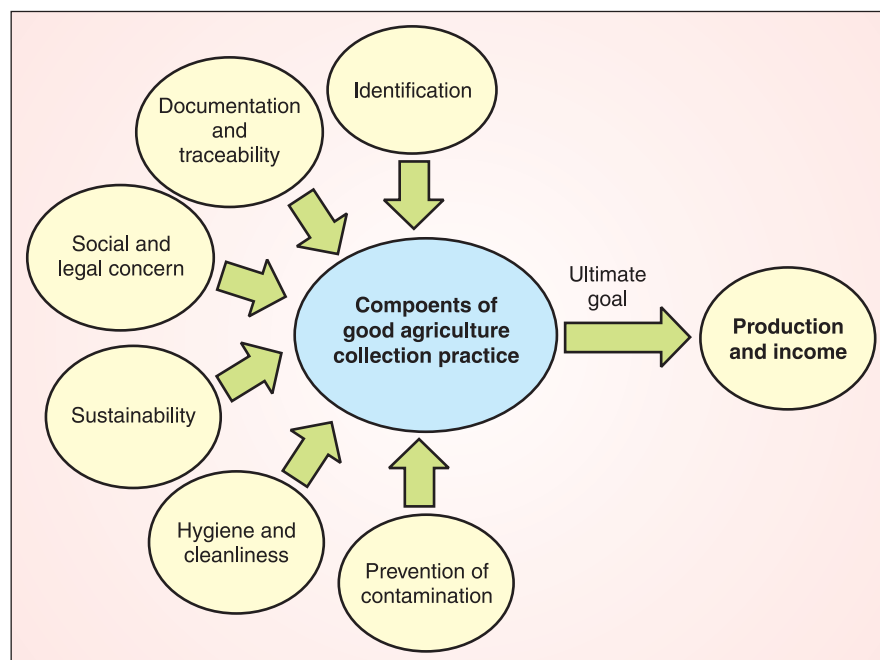


Fig. 2. Basic components of GACP for sustainable production of quality raw herbal drug

improvement of coordination with suppliers, reduction of risks and liabilities in production leading to fewer recalls and withdrawals of products during distribution, competitive advantages related to costs, the market, credibility and price, market access and recognition by buyers increase the remuneration of the farmers, collectors and producers. These components of good agricultural and collection practice (Fig. 2) help collectors and producer to get higher price by supply quality raw drug to buyers. Agreements between producers and buyers of medicinal plants not only ensure remunerative price to collectors and producers but also assured supply of quality raw herbal drugs to herbal industries.

SUMMARY

Good agricultural practices are meant to provide defined and reproducible production management system for affordable and quality supply of raw herbal drug. There is a need to harmonize the raw herbal drug quality requirements under uniform guidelines through strict compliance with good agricultural practice and good medicinal plants

during production. The good agricultural practice guidelines and specification for growing and handling medicinal plants need to be an intrinsic part of any quality assurance system for plant based health care programme. To comply with international demands of quality raw herbal drug, the entire production system of medicinal plants must be re-examined. Comprehensive protocol within suggested frame work of good agricultural practice need to be developed starting with way-bill detailing the cultivation or collection history of plant materials. Developing a process that meets the needs of stakeholder associate with medicinal plant sector is the most important. This will require cooperation from specialist in production, processing, pharmacology and other associated fields. Further, comply with industry needs and international demands, a systemic details protocol for the process of good agricultural practice needs to be established for each medicinal plant species and also for each region.

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Handbook of Integrated Pest Management. 2018. Dr C. Chattopadhyay *et al.* Indian Council of Agricultural Research, KAB-I, Pusa, New Delhi 110 012. 16.5 cm × 25.5 cm. pp. i-x+1-768. ₹ 1,500/- ISBN : 978-81-7164-179-6.

To reverse the loss of environmental resources and also to reduce biodiversity loss, the Government of India has Integrated Pest Management (IPM) as part of the National Agricultural Policy. Integrated Pest Management emphasizes the growth of a health crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. IPM is not new – mechanical, cultural and biological tactics were used by farmers for hundreds of years before chemical pesticides became available. Besides, there are IPM techniques that have been developed more recently and are effective in suppressing pests without adversely affecting the environment.

The task of spreading the message of IPM across is tough due to poor awareness about the subject among people in line-departments as also among the farmers. The information on integrated pest management as a whole is scattered. This *Handbook* comprehensively deals with all the aspects of integrated pest management in field crops, horticultural crops under traditional, protected systems. Information on basic strategies and tactics of different methods of management including mass production of biocontrol agents, IPM policy and pesticide registration is provided in comprehensive form.

The *Handbook of Integrated Pest Management* comprises 82 chapters which are well written in lucid language with crispy sentences by the renowned scientists. The role of IPM is elucidated with different pests like *Trichogramma*, *Bacillus thuringiensis*, *Nomuraea rileyi* etc. and agricultural crops like rice, wheat, maize, sorghum, pearl millet, pulses, soybean, rapeseed mustard, groundnut, minor-oilseed crops, sugarcane, cotton, jute and mesta, potato, vegetable crops, fruits, grapes, citrus, banana, pomegranate, coconut etc. This *Handbook* will provide information of available useful technologies to educate on how to reduce or judiciously use chemical pesticides, safeguard ourselves from chronic poisoning, save the National environment while also reducing input costs and raise farmers' income. This compilation will be useful to teachers, students, trainers, line-department personnel and policy makers.



Livestock Breeding: From Concept to Application. 2018. Umesh Singh *et al.* Indian Council of Agricultural Research, KAB-I, Pusa, New Delhi 110 012. 16 cm × 24 cm. pp. i- viii +1-275. ₹ 580/- ISBN :978-81-7164-178-9.

Animal breeding especially artificial breeding has the history of more than 300 years and a lot has been achieved by now. The traits of economics importance in various livestock species have improved several times to meet the human requirements through the implementation of various genetic improvement programme. However, today the world production merely meets the demand to a significant extent. Further to feed the growing population in future, it may be essential to produce more with abridged resources. So, today the animal breeding cannot be restricted with the traditional breeding techniques, viz. selection and breeding as the genetic improvement achieved through these method is very low and time consuming. Recent development in the field of molecular biology have opened new avenues for identifying variation at genomic level using advanced molecular tools and analyzing the molecular data using appropriate statistical methods. The developments in the field of animal breeding is related with changes in the society, in terms of the techniques availability and market demand.

The *Textbook on Livestock Breeding: From Concept to Application* is written in a simple, concise and comprehensive manner to facilitate better understanding to the basic and fundamental principles of animal breeding. The content of this book is in accordance with the Veterinary Council of India (VCI) syllabus for the Bachelor of Veterinary and Animal Science course. However, this book will also address the needs of students of Animal Husbandry, Animal Science and Biological Sciences who study the the basic animal breeding as part of their curriculum at college level. This book will be helpful for the undergraduate as well as postgraduate students, teachers of Animal Breeding and Genetics in agricultural universities and other educational institutions etc.

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