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0**Survey of selected raw drug markets of Kerala for identifying adulteration and substitution in medicinal plants: A burning problem in herbal industry****Satheesh George, Aparna V, Ardra Prem, Athira R, Binusha CP, Filip Sebastian, Binu Thomas***

Department of Botany, Centre for Post Graduate Studies and Research, St. Joseph's College (Autonomous), Devagiri, Calicut- 673008, Kerala, India.

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ABSTRACT: Background: Herbal medicine has been shown to have genuine utility. In fact today, approximately 70 % of synthetic medicines are derived from plants. Popularity among the common people increased the usage of medicinal plants/herbal drugs. **Aim:** The present study was aimed to identify adulteration and substitution in medicinal plants which are used to prepare various herbal formulations. **Methods:** Methodology includes Sample collection, Identification of raw drugs, Identification of quality status of the raw drug. **Results:** The results of the present study has summarized in following heads namely Adulteration with substandard varieties, Adulteration with superficially similar but inferior drugs, Replacement by exhausted drugs, substitution with taxonomically related plants, Controversy and controversial drugs. **Conclusion:** Substitution is a replacement of equivalent drugs in place of original drugs on the basis of similar pharmacological actions and therapeutic uses. It should be properly validated in contemporary context using both Ayurvedic principles and Modern Scientific tools. Based on these standards, adulteration whether, intentional or unintentional, should be rejected. Collectors, suppliers and traders should be educated for authentic sources of drugs.

Corresponding author*

Dr. Binu Thomas
Assistant Professor
St. Joseph's College (Autonomous),
Devagiri, Calicut - 673008,
Kerala, India.
Tel: +91-8848649762
Mail ID: binuthomasct@gmail.com

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INTRODUCTION:

India is one of the world's top 12 mega diversity countries. It has more than one fourth (8000) of the world's known medicinal plant species (30,000), which provides an important source of medicinal raw materials for traditional medicine systems as well as for pharmaceutical industries^[1]. Medicinal plants are globally valuable sources of new drugs. There are over 1300 medicinal plants used in Europe, of which 90 % are harvested from wild resources; similar figure in India

also [2]. Furthermore, up to 80 % of people in developing countries are totally dependent on herbal drugs for their primary healthcare, and over 25 % of prescribed medicines in developed countries are derived from wild plant species [3].

Similarly a large percentage of plants used in herbal industries are subject of controversy. At present the adulteration and Substitution of the herbal drugs is the burning problem in herbal industry and in Ayurvedic practices. Adulterants are also creating health hazards or adverse events. Similarly controversy is creating problem for uniformity in standardization and reliability of Ayurvedic products and due to use of substitutions, it is difficult to get the appropriate effects as the genuine drugs could give [4].

At present the adulteration and substitution of herbal drugs is the burning problem in herbal industry. The deforestation and extinction of many species and incorrect identification of many plants has resulted in adulteration and substitution of raw drugs [5]. It is a practice of adding foreign substance in place of original crude drug partially or fully which is inferior or substandard in therapeutic and chemical properties or addition of low grade or spoiled drugs or entirely different drug similar to that of original drug adding which an intention of enhancement of profits [6]. Due to adulteration, faith in herbal drugs has declined. Adulteration in market samples is one of the greatest drawbacks in promotion of herbal products. Medicinal plant dealers have discovered the scientific methods in creating adulteration of such a high quality that without microscopic and chemical analysis, it is very difficult to trace these adulterations [7,8].

The present study mainly aims to identify adulteration and substitution in medicinal plants which are used to prepare various herbal formulations.

MATERIALS AND METHODS:

Sample collection:

Selected raw drug samples such as Amrutha, Brahmi, Daruharidra, Devadaru, Pashanabheda, Vasa and Vizhal were collected from the following markets (Table 1). Minimum quantity was purchased depending upon the cost and nature of the material.

Identification of raw drugs:

The raw drug samples collected from different markets across Kerala were identified mostly based on organoleptic characters.

Identification of quality status of the raw drug:

Visual inspection was carried out to detect the quality of raw drugs collected from various markets across Kerala for identifying microbial contamination, presence of unwanted materials, adulteration with substandard commercial varieties, adulteration with superficially similar but inferior drugs, replacement by exhausted drugs.

Table 1. List of markets in which raw drug samples were collected.

Sl. No.	Locality
1	Thiruvananthapuram
2	Alappuzha
3	Pathanamthitta
4	Kottayam
5	Thrissur
6	Palakkad
7	Malappuram 1
8	Malappuram 2
9	Kozhikode 1
10	Kozhikode 2
11	Wayanad
12	Kannur
13	Kasaragod

RESULTS AND DISCUSSION:

Adulteration in market samples is one of the greatest drawbacks in promotion of herbal products. It is invariably found that the Adverse Event Reports are not due to the intended herb, but rather due to the presence of an unintended herb. Medicinal plant dealers have discovered the scientific methods in creating adulteration of such a high quality that without detailed analysis, it is very difficult to trace these adulterations (Table 2 and 3). Adulteration in simple term is degradation of an article. Drugs are generally adulterated or substituted with substandard, inferior or artificial drugs.

Adulteration with substandard varieties:

Adulterants resemble the original crude drug morphologically, but are substandard in nature and cheaper in cost. This is the most common type of adulteration; example is *Cedrus deodara* is adulterated with *Pinus* species.

Adulteration with superficially similar but inferior drugs:

Inferior drugs may or may not have any chemical or therapeutic value. They resemble only morphologically, so due to its resemblance they are used as adulterants.

Common example *Coscinium fenestratum* are adulterated with *Anamirta cocculus* or *Morinda* species.

Replacement by exhausted drugs:

Admixture of the same drug which is devoid of medicinally active substances as it has been extracted already. Drugs like *Amrutha* are adulterated by this method. From some raw drug markets powdered samples of *Tinospora* species which is devoid of color and smell due to extraction are received.

Table 2. The genuine source plants of the selected raw drugs.

Sl. No.	Raw drug	Genuine source plant
1	Amrutha	<i>Tinospora cordifolia</i>
2	Brahmi	<i>Bacopa monnieri</i>
3	Daruharidra	<i>Coscinium fenestratum</i>
4	Devadaru	<i>Cedrus deodara</i>
5	Pashanabheda	<i>Aerva lanata</i>
6	Vasa	<i>Justicia beddomei</i>
7	Vizhal	<i>Embelia ribes</i>

Substitution with taxonomically related plants:

Some raw drug samples are substituted with easily available taxonomically related plants. In our study 'vasa' collected from all the raw drug markets were *Justicia adhatoda* instead of *Justicia beddomei*.

Controversy and controversial drugs:

Controversial drugs or Sandigdha dravyas are those plants which are mentioned in Ayurveda classics but their botanical identification is not clear. The Ayurvedic and Sanskrit literature has described an herb with many synonyms, which do not precisely indicate the botanical source but many a times attribute to therapeutic utility of the plant. For a single herb various synonyms are mentioned in Ayurvedic dictionaries on the basis of morphology, habitat, origin, and therapeutic uses etc. by using different similes which are leading causes of controversy. Quantum of information gained from Ayurvedic and other Sanskrit literature revealed various incidences where on common vernacular name is used for two or more entirely different plant species in Ayurvedic and other traditional system of medicines e.g. 'Pashanabedha' is used for *Aerva lanata*, *Bergenia ligulata*, *Bridelia crenulata*, *Bryophyllum calycinum*, *Coleus amboinicus*, *Decalepis arayalpathra*, *Homonoia*

riparia, *Rotula aquatic* and *Didymocarpus pedicallata* which are totally different drugs. Mistake done during copying of Manuscripts. In past there was no printing machine, Acharyas had written the manuscript manually in *Bhurja-Patra* or *Taalpatra* or other substances. During copying of these manuscripts by editors or translators, mistakes might have occurred, which ultimately created controversy. Single synonym given for multiple plants- In Ayurvedic dictionaries single synonym is used for two or more than two herbs which are totally different in morphology which creates controversy.

Presence of vegetative matter of same plant:

Instead of proper used parts of crude drugs other parts of same species are mixed with genuine crude drugs. For example instead of whole plant of 'vasa' (*Justicia beddomei*) stem, root or leaves of plant is used.

Adulteration is a practice of substituting original crude drug partially or wholly with other similar looking substances but later is either free from or inferior in chemical and therapeutic properties. In simple word, it is debasement of an article. On the basis of motive; adulteration is intentional or direct and accidental or indirect adulteration. Direct or intentional adulteration is mainly done for commercial benefits. Deterioration, admixture, sophistication, substitution, inferiority and spoilage are methods of adulteration. Intentional impairment in the quality of drug is deterioration.

Substitution is a replacement of equivalent drugs in place of original drugs on the basis of similar pharmacological actions and therapeutic uses. In Ayurveda, substitution is described by the name of *Abhava*, *Pratinidhi*, *Dravya*. During *Samhita* Period concept of adulteration and substitution was not existed but later on this practices come in existence. But *Vagbhatta* has mentioned that the *dravya* having similar *Ras* (taste), *Guna* (characteristic), *Veerya* (potency) and *Vipaka* should be used in absence of each other. So *Abhava Pratinidhi Dravya* is a replacement of original drug basically having similar *Rasa*, *Guna*, *Veerya*, *Vipak* and mostly on *Karma*. Description of *Abahva*, *Pratinidhi*, *Dravyas* are mentioned in *Bhavaprakash*, *Nighantu*, *Yogratnakar* and *Bhaishajya-Ratnawali*.

Medicinal plants becoming red listed. It provided greater scope for the physician to utilize herbs that are easily available, cost effective and most appropriate for the clinical condition. It is not that all adulterations are intentional malpractice as stated in many literatures. With our experience it is noted that the herbal drugs are

Table 3. Status of different Ayurvedic drugs and source plants received from various markets.

Sl. No.	Raw drug	Genuine source plant	Plants received from various markets
1	Amrutha	<i>Tinospora cordifolia</i>	<i>Tinospora cordifolia</i> <i>Tinospora sinensis</i> Powdered material
2	Brahmi	<i>Bacopa monnieri</i>	<i>Bacopa monnieri</i> Infected plants
3	Daruharidra	<i>Coscinium fenestratum</i>	<i>Coscinium fenestratum</i> <i>Morinda</i> sp. <i>Anamirta cocculus</i>
4	Devadaru	<i>Cedrus deodara</i>	<i>Pinus</i> sp.
5	Pashanabheda	<i>Aerva lanata</i>	<i>Aerva lanata</i>
6	Punarnava	<i>Boerhavia diffusa</i>	<i>Boerhaavia diffusa</i> Unidentified materials
7	Vasa	<i>Justicia beddomei</i>	<i>Justicia adhatoda</i> Whole plant and Root
8	Vizhal	<i>Embelia ribes</i>	<i>Embelia ribes</i> <i>Embelia tsjeriam-cottam</i>

adulterated unintentionally also. Suppliers are illiterate and not aware about their spurious supply. Nowadays, Ayurvedic drug industries follow high quality standards using modern techniques and instruments to maintain their quality. World Health Organization (WHO), in its publication on quality standards for medicinal plant materials, recommends rejecting any batch of raw material, which has more than 5 % of any other plant part of the same plant (e.g. stem in leaf drugs), never the less if they are derived from the authentic plant. Based on these standards, adulteration whether, intentional or unintentional, should be rejected. Also, suppliers and traders should be educated about the authentic sources.

Controversy, Adulteration and Substitution are interrelated with each other. Substitution practices if exists for long time the original identity of a plant may become obscure and the substitute will be considered as the original, leading to create controversy. Non-availability and high market price of crude drugs led to adulteration. Similarly controversy about authentic botanical source of medicinal plants dealt in classical Ayurveda texts led a cause of substitution because of lack of proper authentication, the drugs having similar morphology or similar therapeutic effects might be practiced. Controversy, adulteration and substitution create problems for standardization of Ayurvedic practices and herbal products. Substitution of genuine drug is need of time because of unavailability of genuine drugs due to deforestation, global warming, lack of adequate cultivation practices etc. It should be properly

validated in contemporary context using both Ayurvedic principles and modern scientific tools. Based on these standards, adulteration whether, intentional or unintentional, should be rejected. Collectors, suppliers and traders should be educated for authentic sources of drugs. Intentional adulteration should be discouraged by strictly implementing the regulatory laws. Due to adulteration faith in Ayurvedic practices and drugs has declined and adulteration in market samples is the greatest drawback in promotion of herbal drugs. So for quality, safety and standardization purpose of Ayurvedic products and practices the problem related with controversy, substitution and adulteration of drugs should be resolved for its worldwide acceptance.

CONCLUSION:

The prime factor for resolution of controversy is the proper authentication of botanical source of medicinal herbs mentioned in classics, for this, literature review, ethno-botanical survey, medicinal plants survey and drug evaluation (morphological, microscopic, chemical, physical and biological evaluation) should be done. Similarly for determination and detection of adulteration, various steps of drug evaluation should be applied. Substitution of drugs should only suggested when therapeutic efficacy of substituted drug is similar to original one. The uniformity in selection of crude drugs for pharmaceutical preparations and practices should maintain the standardization of Ayurvedic products and for this Ayurvedic pharmacopeia of India (API) and Ayurvedic formulary of India (AFI) is playing

a vital role, so maximum number of drugs mentioned in classics and practiced traditionally should be incorporated in API and AFI.

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