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ADULTERATION IN MEDICINAL PLANTS AND HERBAL DRUGS

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ABSTRACT

Medicinal plants are considered as an effective source of traditional and modern medicine. In 20th and 21st century due to side effects of synthetic drugs, there is an increasing interest in Ayurvedic proprietary medicines. In India, about 80% of the rural population depends on medicinal herbs and/or indigenous system of medicine for primary health care. Adulterants and substitutes are the common malpractices in herbal raw material trade. Adulteration is considered as an intentional addition of foreign substances to increase the weight of the product or to decrease its cost. It may be due to Confusion in vernacular names, Lack of knowledge about authentic plants, Non availability, Similarity in morphology, activity, aroma, Careless collection and other unknown reasons. So, understanding of all the ways of adulteration and substitution is necessary to rectify this illegal act and maximizing consumer's safety.

Keywords: Medicinal plants, health, adverse effect, cultivation and adulteration.

INTRODUCTION

The adulteration and substitution of herbal drugs is the burning problem in herbal industry and it has caused a major effect in the commercial use of natural products. Populations of many species have limited distribution in their natural habitats, requiring conservation strategies for protection. Unavailability of such medicinal plants has led to arbitrary substitution and adulteration of raw drug in the market (Tewari *et al.*, 1991 and Bisset *et al.*, 1984). Adulteration more precisely defined as a practice of substituting original crude drug partially or whole with other similar looking substances which are either free from or inferior in chemical and therapeutic properties or addition of low grade or spoiled drugs or entirely different drug similar to that of original drug substituted with an intention of enhancement of profits (Kokate *et al.*, 2007 and Mukherjee *et al.*, 2002).

A adulteration may also be defined as mixing or substituting the original drug material with other spurious, inferior, defective, spoiled, useless other parts of same or different plant or harmful substances or drug which do not

confirm with the official standards. A drug shall be deemed to be adulterated if it consists, in whole or in part, of any filthy, putrid or decomposed substance (The Drugs and Cosmetics Act., 1940 and The Drugs and Cosmetics Rule., 1945) Adulteration is described as intentional substitution with another plant species or intentional addition of a foreign substance to increase the weight or potency of the product or to decrease its cost. In general, adulteration is considered as an intentional practice. Due to adulteration, faith in herbal drugs has declined (Dubey *et al.*, 2004). Adulteration in market samples is one of the greatest drawbacks in promotion of herbal products.

ADULTERATION MAY TAKES PLACE BY TWO WAYS:

- Direct or intentional adulteration
- Indirect or unintentional adulteration

Direct or intentional adulteration

Direct or intentional adulteration is done intentionally which usually includes practices in which an herbal drug is substituted partially or fully with other inferior products.

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Due to morphological resemblance to the authentic herb, many different inferior commercial varieties are used as adulterants. These may or may not have any chemical or therapeutic potential. Substitution by “exhausted” drugs entails adulteration of the plant material with the same plant material devoid of the active constituents. This practice is most common in the case of volatile oil-containing materials, where the dried exhausted material resembles the original drug but is free of the essential oils. Foreign matter such as other parts of the same plant with no active ingredients, sand and stones, manufactured artefacts, and synthetic inferior principles are used as substitutes. The practice of intentional adulteration is mainly encouraged by traders who are reluctant to pay premium prices for herbs of superior quality, and hence are inclined to purchase only the cheaper products. This encourages producers and traders to sell herbs of inferior quality. (Jaya Preethi *et al.*, 2014)

Indirect or unintentional adulteration

Unintentional or undeliberately adulteration which sometimes occurs without bad intention of the manufacturer or supplier. Sometimes in the absence of proper means of evaluation, an authentic drug partially or fully devoid of the active ingredients may enter the market. Factors such as geographical sources, growing conditions, processing, and storage are all factors that influence the quality of the drug (Poornima *et al.*, 2010).

Faulty collection

Some of the herbal adulteration is due to the carelessness of herbal collectors and suppliers. The correct part of genuine plant should be collected. Other less valuable part of the genuine plant should not be collected. Moreover collection should be carried out at a proper season and time when the active constituents reach maximum. *Datura strumarium* leaves should be collected during flowering stage and wild cherry bark in autumn etc. collection from other plant by ignorance, due to similarity in the appearance, color, lack of knowledge may lead to adulteration. For example in place of *Aconitum napellus*, the other *Aconitum deinochizum* may be collected or in place of *Rhamnus purshiana* (cascara bark) *Rhamnus colifornica* is generally collected. Confusion existing in the common vernacular name of different plant in various states of India may lead to this type of adulteration. Often in different states the same plant is known by different vernacular names, while quite different drugs are known by same name. This creates confusion which is best illustrated by Punarnava and Brahmi. The Indian pharmacopoeia drugs *Trianthema portulacastrum* L. and *Boerhavia diffusa* L. are both known by the same vernacular name “Punarnava” (Jaya Preethi *et al.*, 2014).

Imperfect preparation

Non removal of associated structures e.g. stems are collected with leaves, flowers, fruits. Non-removal of undesirable parts or structures e.g. cork should be removed from ginger rhizome. Proper drying conditions should be adhered. Improper drying may lead to unintentional adulteration e.g. if digitalis leaves are dried above 65°C decomposition of glycosides by enzymatic hydrolysis. Use of excessive heat in separating the cod liver oil from livers, where the proportions of vitamins, odour and color etc are adversely affected (Jaya Preethi *et al.*, 2014).

Incorrect storage

Deterioration especially during storage, leading to the loss of the active ingredients, production of metabolites with no activity and, in extreme cases, the production of toxic metabolites. Physical factors such as air (oxygen), humidity, light, and temperature can bring about deterioration directly or indirectly. These factors, alone or in combination, can lead to the development of organisms such as molds, mites, and bacteria. Oxidation of the constituents of a drug can be brought about by oxygen in the air, causing some products, such as essential oils, to resinify or to become rancid. Moisture or humidity and elevated temperatures can accelerate enzymatic activities, leading to changes in the physical appearance and decomposition of the herb. For example volatile oils should be protected from light and stored in well closed containers in cool place. Belladonna leaf should be stored in moisture free containers, which may cause enzymatic action lead to decomposition of medicinally active constituents. Mites, nematode worms, insects/moths, and beetles can also destroy herbal drugs during storage (Jaya Preethi *et al.*, 2014).

Gross substitution with plant material

Due to morphological resemblance i.e. similarity in appearance, colors etc the genuine crude drugs are substituted with others are very often sold in the market e.g. *Podophyllum peltatum* L. is used as a substitute for *P. hexandrum*, *Belladonna* leaves are substituted with *Ailanthus* leaves.

Substitution with exhausted drugs

In this type, the same drug is admixed but devoid of any medicinally active constituents as they are already extracted out. This practice is more common in case of volatile oil containing drugs sometime, natural characters of exhausted drugs like color and taste are manipulated by adding other additives and then it is substituted e.g. exhausted gentian made bitter with aloes.

Reasons for adulteration

Confusion in Vernacular Names:

In Ayurveda, Parpatta refers to *Fumaria parviflora*. In Siddha, 'Parpadagam' refers to *Mollugo pentaphylla*. Owing to the similarity in the names in traditional systems

of medicine, these two herbs are often interchanged or adulterated or substituted. Because of the popularity of Siddha medicine in some parts of South India, traders in these regions supply *Mollugo pentaphylla* as Parpatta/Parpadagam and the North Indian suppliers supply *F. parviflora*. These two can be easily identified by the presence of pale yellow to mild brown colored, thin wiry stems and small simple leaves of *Mollugo pentaphylla* and black to dark brown colored, digitate leaves with narrow segments of *F. parviflora*. *Casuarina equisetifolia* for *Tamarix indica* and *Aerva lanata* for *Berginiaciliate* are some other example for adulterations due to confusion in names (Sarin *et al.*, 1996).

Lack of Knowledge About Authentic Source

Nagakesar is one of the important drugs in Ayurveda. The authentic source is *Mesua ferrea*. However, market samples are adulterated with flowers of *Calophyllum inophyllum*. Though the authentic plant is available in plenty throughout the Western Ghats and parts of Himalayas, suppliers are unaware of it. There may also be some restrictions in forest collection. Due to these reasons, *C. inophyllum* (which is in the plains) is sold as Nagakesar. Authentic flowers can be easily identified by the presence of two-celled ovary whereas in case of spurious flowers they are single celled (Sarin *et al.*, 1996).

Similarity in Morphology

Mucuna pruriens is adulterated with other similar Papilionaceae seeds having similarity in morphology. *M. utilis* (sold as white variety) and *M. deeringiana* (sold as bigger variety) are popular adulterants. Apart from this *M. cochinchinensis*, *Canavalia virosa* and *C. ensiformis* are also sold in Indian markets. Authentic seeds are up to 1 cm in length with shining mosaic pattern of black and brown color on their surface. *M. deeringiana* and *M. utilis* are bigger (1.5-2 cm) in size. While *M. Deeringiana* is dull black and *M. utilis* is white or buff colored (Sarin *et al.*, 1996).

Lack of Authentic Plant:

Hypericum perforatum is cultivated and sold in European markets. In India, availability of this species is very limited. However, the abundant Indo-Nepal species *H. patulum*, sold in the name of *H. perforatum*. Market sample is a whole plant with flowers and it is easy to identify them taxonomically. Anatomically, transverse section of *H. perforatum* stem has compressed thin phloem, hollow pith and absence of calcium oxalate crystals. Whereas *H. patulum* has broader phloem, partially hollow pith and presence of calcium oxalate crystals (Pawan Kumar *et al.*, 2014).

Similarity in Color

It is well known that with course of time, drug materials get changed to or substituted with other plant species. 'Ratanjot' is a recent day example. According to the suppliers and non-timer forest product (NTFP) contractors, in the past, roots of *Ventilago madraspatana* were collected from Western Ghats, as the only source of 'Ratanjot'. However, that has not been practiced now. It is clearly known that *Arnebia euchromavareuchroma* is the present source. Similarity is in yielding a red dye, *A. euchroma* substitutes *V. madraspatana*. Recently *V. madraspatana* is not found in market. Whatever is available in the market, in the name of Ratanjot is originated from *A. Euchroma* (Mitra *et al.*, 2007 and Chouhan *et al.*, 1999).

Careless Collections

Some of the herbal adulterations are due to the carelessness of herbal collectors and suppliers. *Parmelia perlata* is used in Ayurveda, Unani and Siddha. It is also used as grocery. Market samples showed it to be admixed with other species (*P. perforata* and *P. cirrhata*). Sometimes, *Usnea* sp. is also mixed with them. Authentic plants can be identified by their thallus nature (Poornima *et al.*, 2010 and Roy *et al.*, 2013).

ADULTERATED OR SUBSTITUTE PARTS USED IN MEDICINAL PLANTS

Sl. No	Original and costly Raw Drugs	Botanical name	Adulterated/Substitute drug	Botanical name
1.	Tulasi	Ocimum sanctum	Nirgundi	Vitex negundo
2.	Asoca	Saraca asoca	False ashoka	Polyanthia longifolia
3.	Indian senna	Cassia angustifolia	Dog senna	Cassia abovata
4.	Alexandrian senna	Cassia acutifolia	Palthe senna	Cassia auriculatad
			Dog senna	Cassia abovata
			Palthe senna	Cassia auriculatad
5	Aloes	Aloe barbadensis	Natal aloes	Aloe barberae

6.	Digitalis	Digitalis purpurea	Primrose	Primula vulgaris
7.	Liquorice	Glycyrrhiza glabra	Russian Liquorice	Glycyrrhiza echinata
8.	Opium	Papaver somniferum	Turkish opium	
9.	Belladona	Atropa belladonna	Black nightshade	Solanum nigrum
10.	Bakula	Mimusops elengi	Kamala	Nelumbo nucifera
11.	Puskar mool	Inula racemosa	Eranda(root)	Ricinus communis
			Kustha	Saussurea lappa
12	Bharangi	Clerodendrum serratum	Kantakari	Solanum xanthocarpum
13	Tagar	Valeriana wallichii	Kustha	Saussurea lappa
14	Chavya	Piper chaba	Pippali (root)	Piper longum
15	Draksha	Vitis vinifera	Kashmari phala	Gmelina arborea
16	Chitrak	Plumbago zeylanica	Danti	Baliospermum montanum
17	Dhanavayasa	Fagonia cretica	Duralabha	Alhagi pseudalhagi
18	Ahimsa	Capparis sepiaria	Manakanda	Alocasia indica
19	Bhallataka	Semecarpus anacardium	Nadi Bhallataka	Semecarpus Travancorica
20	Murva	Marsdenia tenacissima	Jinghini	Lannea coromandelica
21	Ikshu	Saccharum officinarum	Nala	Arundo donax
22	Ativisha	Aconitum heterophyllum	Mustaka	Cyperus rotundus
23	Riddhi and Vriddhi	Hobenaria spp.	Varahikanda	Dioscorea bulbifera
24	Kakoli	Lilium polyphyllum	Asvagandha	Withania somnifera
25	Kshirakakoli	Fritillaria roylei	Asvagandha	Withania somnifera
26	Karpua	Cinnamomum Camphora	Granthi parna	Leonotis nepetifolia
27	Dadim	Punica granatum	Vrikshamla	Garcinia indica
28	Kusha	Desmostachya bipinnata	Kasha	Saccharum spontaneum
29	Kutherika	Ocimum basilicum	Gramya tulasi	Ocimum sanctum
30	Nagapuspa	Mesua ferrea	Padma kesar	Nelumbo nucifera
31	Vatsnabh	Aconitum Chasmanthum	Mohri	Aconitum ferox wall
32	Ativisha	Aconitum heterophyllum	Mustaka	Cyperus rotundus
33	Kutki	Picrorhiza kurroa royle ex	Kuth or Kout	Saussurea castus
34	Kuth or Kustha	Saussurea lappa	Kuth or Kout	Saussurea castus
35	Puskar mool	Inula racemosa	Kustha	Saussurealappa
36	Jatamansi	Nardostachys Jatamansi	Bhootkeshi	Selinum vaginatum
37	Guggulu	Commiphora wightii	Babul, Kikar	Acacia nilatica
			Myrrha gond or myrrh gum	Commiphora myrrha
38	Rumi Mastagi	Pistacia lentisecus Linn	Salai guggul or Gum olibanum	Frankincense indica

39	Riddhi	Hobenaria intermedia	Varahikand	Dioscorea bulbifera
			Chiriya Musali	Asparagus filicinus
40	Vriddhi	Habenaria edgeworthii	Varahikand	Dioscorea bulbifera
			Salam Panja	Dactylorhiza hatagirea
			Maha bala	Sida acuta Burm. f
41	Kakoli	Rosea purpurea Smith	Ashwagandha, Asrol, Asgandh Nagori	Withania somnifera Dunal
			Kali Musali	Corculigo orchiods
42	Kshirakakoli	Fritillaria roylei Hook	Ashwagandha, Asrol, Asgandh Nagori	Withania somnifera Dunal
			Safed Musali	Chlorophytum arundinaceum
43	Jeevak	Crepipium acuminatum	Varahikand	Dioscorea bulbifera
			Safed behman	Centaurea behen
			Guruchi	Tinospora cordifolia
44	Rishbhak	Malaxis muscifera	Varahikand	Dioscorea bulbifera
			Lal behmen	Centaurium roxburghi
45	Meda	Polygonatum verticillatum	Satavari	Asparagus racemosus willd
			Salam mishri	Eulophia campestris wall
46	Maha meda	Polygonatum Vertecillatum	Satavari	Asparagus racemosus willd
			Shakakul mishri	Polygontatum multiflorum
			Prasarani	Paederia foetida Linn
47	Rakta Chandana or Sandal Surkh	Pterocarpus santalinus Linn	Red Capsicum, Lal shimla mirch	Capsicum annum Linn., Capsicum baccatum Linn. and Capsicum frutescens Linn
48	Sveta Chandana or Sandal Safed	Pterocarpus santalinus Linn	White Capsicum, Safed shimla mirch	Capsicum annum Linn

Remedies of adulteration

- Cultivation of medicinal plants
- Judicious collection of medicinal plants from wild
- Right collection at right time
- Identification/Authentication
- Building up a Herbarium & Museum

CONCLUSION

Adulteration of medicinal plants is not only intentional malpractice as stated in many literatures. With experience it is noted that the herbal drugs are adulterated

unintentionally also. Major causes for adulteration are confusion in vernacular names, Non availability, Lack of knowledge about authentic plants, Similarity in morphology, activity, aroma, Careless collection and other unknown reasons. Suppliers are illiterate and not aware about their spurious supply Even scientific community and traditional physicians are unaware of it. 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. After understanding the ways of adulteration, more research and information required to rectify and minimize the illegal act adulteration, for improving consumers' safety. For this purpose we can take help from scientific literature, expert opinion, pharmacology, kinetics/dynamics, interactions, adverse effects, toxicology and dosing.

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