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REVIEW ARTICLE

Adulteration and Substitution of Medicinal Plant: A Burning Problem in Herbal Industry

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ABSTRACT

Medicinal plants constitute an effective source of traditional and modern medicine. 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. Many Substitute Drugs are mentioned in *Ayurvedic* texts. The principles to select substitute drugs are based on similarity of properties (*Rasa*, *Guna*, *Virya* and *Vipaka)* but most important factor is therapeutic action (*Karma).* In present era number of species in endangered plant list is increasing very fast. In this scenario selection of substitute drugs may be the right option.

Key words- *Ayurveda*, Adulteration, Substitute drug.

INTRODUCTION

Ayurveda is a system of Indian traditional form of alternative medicine. Adulteration and Substitution are frequent in raw material trade of medicinal plants. Herbal adulteration is one of the common malpractices in herbal raw material trade. 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[1,2]. The term adulteration of an article covers a number of conditions which may be intentional or accidental. 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[3,4,5]. Due to adulteration, faith in herbal drugs has declined. Adulteration in market samples is one of the greatest drawbacks in promotion of herbal products. In adulterated drugs, 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[6,7,8]. 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 [9,10,11,12].

Many substitute drugs are mentioned in *Ayurvedic* texts. The principles to select substitute drugs is based on similarity of properties (*Rasa*, *Guna Virya* and *Vipaka)* but most important factor is therapeutic action (*Karma).* In terms of pharmacy, substitute is generally used when original drugs are not available or may be available in small quantity. In ancient time, *Vaidya* had to collect the drug by own. The drugs which were less available in local area were replaced by other drugs known as substitute drugs (*Pratinidhi Dravyas).* The ancient *Acharyas* e.g. *Charaka* and *Sushruta* have not given direct references or listed substitute drugs but, *Acharya Vagbhata* has

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stated that in case of non availability of any particular drug in the preparation of compound formulation one should try to get another which is similarly potent and has similar *Rasa(Taste), Guna(Property), Virya(Potency)* and *Vipaka*. Detail description regarding substitute drugs can be traced from the text books like *Bhavaprakasha* (Author *Bhavamishra,* 16th century), *Yogaratnakara* (Author Unknown, 17th century) and *Bhaishajya ratnavali* (Author *Govind* Das,14th century) **[13,14,15,16]**.

Table 1: Difference between adulterants and substitutes

S. No.	Adulterants	Substitutes
1.	Adulteration is the intentional addition of foreign substances to increase the weight of product and to decrease its cost.	Substitute drugs are that drugs which are based on similar properties i:e Rasa, Guna, Virya and Vipaka and most important is Karma.
2.	In simple words- Adulteration is the debasement of an article.	Substitution is generally done when original drugs are non-available or available in small quantity.
3.	It is added partially or fully which is inferior or substandard in therapeutic and chemical properties.	Vaidya called substitute drugs as *Pratinidhi Dravya.*
4.	Adding low grade or spoiled drugs or entirely different drugs similar to that of original drugs.	*Acharya Charak* and *Susruta* have not given direct references but *Acharya Vagbhat* has stated about substitutes.
5.	Purpose is for enhancement of profits.	Detail description regarding substitute drugs can be traced from the text books of *Bhavaprakasha*, *Yogaratnakara* and *Bhaishajya ratnavali.*
6.	Adulterant drugs are similar to crude drugs in morphology and therapeutically but substandard in nature and cheaper in cost.	Substitution can be done by using totally different drugs species belonging to same family or different species.
7.	Adulteration is also done with artificially manufactured substances.	

MATERIALS AND METHODS

Available *Ayurvedic* Literatures were studied for better understanding of concept of Adulteration and Substitutes drugs. Information regarding adulterant drugs and substitute drugs from various journals, *Ayurvedic* texts and Internet media was also used for availability and necessity for comprehensive understanding of the subject. A detail list of classical drugs and their substitutes with their botanical names was prepared, which was critically studied.

A. METHODS OF ADULTERATING THE DRUGS

Adulteration in simple term is debasement of an article. Drugs are generally adulterated or substituted with substandard, inferior or artificial drugs.

A.1 Adulteration with Substandard Commercial Varieties: Adulterants resemble the original crude drug morphologically, chemically, therapeutically but are substandard in nature and cheaper in cost. This is the most common type of adulteration, example is *Nux-vomica* seed (*strychnos nux-vomica*)are adulterated with *Strychnos nux-blanda* or *Strychnos potatorum* seed.

A.2 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 is adulteration of *cloves* by *mother cloves*. *Saffron* with dried flowers of *Carthamus tinctoria(Safflower).*

A.3 Adulteration with Artificially Manufactured Substance: This type of adulteration is observed in case of drugs which are costly. Examples -Paraffin wax is tinged yellow and adulterated with yellow bees wax, while artificial invert sugar is mixed with honey.

A.4 Replacement by Exhausted Drugs: Admixture of the same drug which is devoid of medicinally active substances as it has been extracted already. Mainly volatile oil containing drugs like *clove, coriander, fennel* are adulterated by this method. As it is devoid of colour and taste due to extraction, natural colour and taste is manipulated with additives.

A.5 Harmful Adulterants: Some harmful materials (adulterants) are collected from market waste materials and admixed with the drug. It is done for the liquid drugs.

A.6 Adulteration of Powders: The drugs which are in the form of powders are frequently adulterated. Examples: dextrin is added in *ipecacuanha*, red sandal wood in *capsicum* powder and powdered bark of drugs adulterated with brick powder**[17,18]**.

B. REASONS OF ADULTERATION

B.1 Confusion in Vernacular Names: In *Ayurveda*, *Parpata* 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. Because of the popularity of Siddha medicine in some parts of South India, traders in these regions supply *Mollugo pentaphylla* as *Parpata/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 *Berginia ciliata* are some other example for adulterations due to confusion in names.

B.2 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 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.

B.3 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.

B.4 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 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 euchroma vareuchroma* 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.uchroma.*

B.5 Careless Collections: Some of the herbal adulterations are due to the carelessness of herbal collectors and suppliers *Parmelia perlata(Shaileya)* 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.

B.6 Other unknown reasons: *Vidari* is another example of unknown authentic plant. Its authentic source is *Pueraria tuberosa* and its substitute is *Ipomea digitata*. However, market samples are not derived from these two. It is interesting to note that an endangered gymnosperm *Cycas circinalis* is sold in plenty as *Vidari*. The adulterated materials originated from Kerala, India. Although both the authentic plant and its substitute are available in plenty throughout India, now *Cycas circinalis* became a major source for this drug due to unknown reasons[19,20].

Table 2: Commonly used adulteration in ayurveda[21,22]

S. No	Main drug	Adulterants
1.	Gum of Gugglu *(Commiphora wightii*)	Gum of Shallaki (*Boswellia serrata*)
2.	Leaf of Araluka (*Ailanthus excels*)	Leaf of Vasaka (*Adhatoda vesica*)
3.	Arimeda (*Acacia fernaciana*)	Aragvadha(*Cassia fistula*)
4.	Kuchala seed (*Strychnos nuxvomica*)	Katak seed (*Strychnos potatorum*)
5.	Manjistha (*Rubia cordifolia)*	Kiratikta(*Swertia chirayta*)
6.	Pattanga(*Caesalpinia sappan*)	Raktachandan (*Pterocarpus santalinus*)
7.	Kampillaka (*Mallotusphillipenensis)*	Istica churna (brick powder)
8.	Yastimadhu (*Glycyrrhiza glabra*)	Gunjamool (*Abrus precatorius*)
9.	Pippali (*Piper longum*)	Chavya (*Piper retrofactum*) and Tambula (*Piper betle*)
10.	Guduchi satva (*Tinospora cordifolia)*	Powder or flour of potato, sweet potato.
11.	Erandkarkati seed (*Caryca papaya*)	Maricha (*Piper nigrum*)
12.	Vidanga (*Embelia ribes*)	Sp.of Vidanga (*Myrsine Africana*)
13.	Arjuna (*Terminalia arjuna*)	Jarula (*Lagerstroemia speciosa*)
14.	Ashoka (*Saraca asoca*)	Kasthadaru (*Polyalthia longifolia*)
15.	Talish patra (*Abies webbiana*)	Sthaunyak (*Taxus baccata*)

C. TYPES OF SUBSTITUTION:

C.1 Using totally different drug: *Bharangi* (Clerodendron indicum) and Kantakari. *Bharangi* has *tikta rasa* and *Laghu ,ruksha guna* and has *Kapha* and *vatahara* property. While Kantakari (*Solanum xanthocarpam*) has *katu*

vipaka and *ushna virya*. It has Glycosides – Verbascoside and Solasoninie, solamargin, solasurine respectively. Both *C. indicum* and *S. xanthocarpam* have shown Anti-hisaminic activity. Both *C. indicum* and *S. xanthocarpam* are commonly employed in the diseases related to the respiratory system, which are commonly associated with release of Histamines and other Autacoids.

C.2 Substitution of the Species Belonging to Same Family: The *Datura metal* and *Datura stramonium* can be considered here. Chemical constituents are Alkaloids- Scopalamine, Atropine, Hyocyamine, Hyoscine etc. The alkaloids are proved as bronchodialator, relaxant and inhibitor of secretion of mucous membrane. The alcoholic extract of *D. metal* shows anti helmentic activity. The alkaloid present in both the species are well proven bronchodilators and also they inhibit the secretion of mucous membrane of the respiratory tract. Thus as far as the diseases of the respiratory tract are concerned both *D.metal* and *D. stramonium* are beneficial, while as Krimihara *D.metal* would be a better choice as it is a proven anti helmentic.

C.3 Substitution of Different Species: Two types of Gokshura –Tribulus terrestris (Zygophylaceae) and *Pedalium murex* (Pedaliaceae). T.terrestris has the chemical constituents like Chlorogenin, Diosgenin, Rutin, Rhamnose, and Alkaloid. While *P.murex* has Sitosterol, Ursolic acid, Vanilin, Flavonoids and Alkaloids. Both the species are proved for Nephroprotective, Lithotriptic, Diuretic and Hepatoprotective activities. If we analyse the clinical conditions where *Gokshura* is indicated i:e- mutrakrrcha, Mutraghata, Ashmari, Prameha etc, both *T. terrestris* and *P.murex* appear to be appropriate.

C.4 Substitution of different parts of the same plant: The root of *Sida cordifolia* and the whole plant of *Sida cordifolia* can be considered. Root has the chemical constituents such as Sitoindoside, Acylsteryglycoside. While the whole plant has Alkaloid, Hydrocarbons, Fatty acids, Ephedrine. Various extracts of the whole plant showed Anti-bacterial, Anti-oxidant, Hypoglycemic, Hepatoprotective and Cardio tonic activities. Though it is the root which is mentioned as official part of *S.cordifolia* in the classics as Balya, Brimhana,Shothahara etc, modern researches prove that even the aerial parts are also equally effective.

C.5 Due to same action: *Embelica officinalis* shows antioxident, hepatoprotective, antimicrobial, hypoglycemic and hypolipidemic action. *Semecarpus* shows anti-tumour, hypotensive, anticytotoxic and anticancerous properties etc. Both *Amalaki* and *Bhallataka* are Rasayana (rejuvenator) drugs. In current practice the Rasayana formulations are being employed as an adjuvant therapy in Chronic as well as Malignant diseases. Amalaki can be employed as Rasayana in Chronic debilitating diseases like bronchial asthma, diabetes etc, while *Bhallataka* would be better choice in malignant conditions, both in solid tumors and in leukemia.

Table 3: Commonly used substitute drugs in ayurveda[27,28,29,30]

S. No.	Common name	Botanical name	Substituted Drug	Botanical name
1.	Murva	*MarsdeniaTenacissima*	Jinghini	*Lannea coromandelica*
2.	Bakula	*Mimusops elengi*	Kamala	*Nelumbo nucifera*
3.	Tagar	*Valeriana wallichii*	Kustha	*Saussrea lappa*
4.	Chavya	*Piper chaba*	Pippali(root)	*Piper longum*
5.	Draksha	*Vitis vinifera*	Kashmari phala	*Gmelina arborea*
6.	Bharangi	*Clerodendrum Serratum*	Kantakari	*Solanum xanthocarpum*
7.	Dhanavayasa	*Fagonia cretica*	Duralabha	*Alhagi pseudalhagi*
8.	Ahimsa	*Capparis sepiaria*	Manakanda	*Alocasia indica*
9.	Bakula (bark)	*Mimusops elengi*	Babul (bark)	*Acacia arabica*
10.	Tulasi	*Ocimum sanctum*	Nirgundi	*Vitex negundo*
11.	Riddhi and Vriddhi	*Hobenaria spp.*	Varahikanda	*Dioscorea bulbifera*
12.	Ikshu	*Saccharum Officinarum*	Nala	*Arundo donax*
13.	Kakoli and Kshirakakoli	*Lilium polyphyllum Fritillaria roylei*	Asvagandha	*Withania somnifera*
14.	Ativisha	*AconitumHeterophyllum*	Mustaka	*Cyperus rotundus*
15.	Dadim	*Punica granatum*	Vrikshamla	*Garcinia indica*
16.	Nagapuspa	*Mesua ferrea*	Padma kesar	*Nelumbo nucifera*
17.	Amlavetas	*Garcinia pedunculata*	Chukra	*Garcinia indica*
18.	Madhuyashti	*Glycyrrhiza glabra*	Dhataki puspa	*Woodfordia fructicosa*
19.	Kusha	*Desmostachya Bipinnata*	Kasha	*Saccharum spontaneum*
20.	Bakuchi	*Psoralea corylifolia*	Chakramarda	*Cassia tora*
21.	Daruharidra	*Berberis aristata*	Haldi	*Curcuma longa*
22.	Jivaka and Rishabhaka	*Microstylis Sp.*	Vidarikanda	*Pueraria tuberosa*
23.	Meda and Mahameda	*Polygonatum sp.*	Satavari	*Asparagus racemosus*
24.	Lakshmana	*Ipomea sepearia*	Mayurashikha	*Actinopteris dichotoma*

D. REASON FOR SUBSTITUTION

D.1 Non-availability of the drug: In case of nonavailability of leaf of the *Abies webbiana* (Talisa patra) leaf of the *Abies baccata* are used.

D.2 Uncertain identity of the drug: For the herb Lakshmana different species such as *Aralia quinquefolia,Ipomea sepiaria* etc are considered.

D.3 Cost of the drug: Kumkuma(Crocus sativas) being costly herb is substituted by Kusumbha(Carthamus tinctorius).

D.4 Geographical distribution of the drug: In North India Premna integrifolia is used as Agnimantha while in South India Arani(Clerodendrum phlomidis) is used.

D.5 The adverse reaction of the drug: Vasa is a well known Rakta-Pittahara (cures bleeding disorder) drug, but due to its abortificiant activity its utility in pregnant women is limited, instead drugs such as Laksha, Ashoka etc are substituted for similar therapeutic effect.

D.6 Seasonal availability of drugs: some drugs are available in specific season so other drugs can be introduced, which have same action. For example:

Trianthema portulacastrum can be used in seasonal absences of *Boerhavia diffusa.*

D.7 Self life of the drug: In case of non avalibility of old *jaggery,* new *jaggery* is used after heating in sun rays for 4 hrs**.**[23,24,25,26]**.**

DISCUSSION

Adulterants and substitutes are different. The most essential criteria for substitution is the Pharmacological activity rather than Morphology or Phytoconstituents. Substitute is rational replacement of herbal drugs to get similar therapeutic action from replaced material. Substitute and Adulteration can be understood in two ways: legally (official substitutes) and illegally (commercial aspect) The legal substitute of the drug is scientifically supported i.e. the drug has the properties which are similar to the original one. Illegal means the drug has been using instead of the original one and is not scientifically supported but it is commercially beneficial to the adulterator or drug dealer.

CONCLUSION

Substitution of the herbs is the need of the hour with more than 300 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 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 [31, 32]**.**

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