



Adulteration and Substitution in Indian Medicinal Plants: A Review Article

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Article Info

Article history:

Received on: 12-04-2022

Accepted on: 22-05-2022

Available online: 31-05-2022

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ABSTRACT:

Introduction: *Ayurveda* is a system of traditional alternative medicine in India. In 20th and 21st century, due to side effects of synthetic drugs, there is an increasing interest in *Ayurveda* proprietary medicines. At present, the adulteration and Substitution of the 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. The future depended upon reliable methodologies for correct identification, standardization and quality assurance of Ayurvedic drugs. This article throws light on the concepts of substitution given by our preceptors and analyzes these with the present-day prevailing trend of adulteration and substitution, thereby aiming at systematic strategy to correctly identify the drugs.

Method: Classical and modern literature along with various Research articles were gone through to collect minute details.

Result: There are different types of Adulterants viz. substandard, inferior, artificial or exhausted drugs. There are many reasons of Adulteration viz. confusion in Vernacular Names, lack of knowledge about authentic source, similarity in morphology, lack of authentic plant, similarity in color, careless collections, etc. There are various types of Substitution viz. using totally different drug, substitution of the species belonging to same family, using different parts of the plant, due to same in action.

Analysis and Discussion: With the help of this thorough review, it is clear that with few basic identification points, one can easily differentiate between adulterated and original drug. Hence, the dealers and handlers of drugs should be made aware of these through training programmes.

Keywords: Adulteration, Substitution, *Ayurveda*, Medicinal Plants.

INTRODUCTION

Adulteration is a practice of substituting the original crude drug partially or fully with other substances which is either

free from or inferior in therapeutic and chemical 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.¹⁻²



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.³ A treatise published two centuries ago (in 1820) on adulterations in food and culinary materials is a proof for this practice as an age-old. Due to adulteration, faith in herbal drugs has declined⁴. Adulteration in market samples is one of the greatest drawbacks in promotion of herbal products. Many researchers have contributed in checking adulterations and authenticating those.^{5,6,7,8,9,10,11,12} It is invariably found that the Adverse Event Reports are not due to the intended herb¹³, 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 microscopic and chemical analysis, it is very difficult to trace these adulterations^{14,15}.

MATERIALS AND METHODS

Classical *Ayurveda* and modern literature, different Databases, Research articles were reviewed to collect the details related to the subject which were then systematically arranged and analyzed to reach substantial conclusions.

Types of Adulterants

Drugs are generally adulterated or substituted with substandard, inferior or artificial drugs.

a) Substitution with substandard commercial varieties: Adulterants resemble the original crude drug morphologically, chemically, therapeutically but substandard in nature and cheaper in cost. This is the most common type of adulteration.

b) Substitution with Superficially similar 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.

c) Substitution with Artificially Manufactured Substance:

The drug is adulterated with the substance which has been prepared artificially. The artificially manufactured substance resembles the original drug. This method is followed for the costlier drugs.

d) Substitution with Exhausted Drug:

The same drug is admixed but that drug is devoid of

medicinally active substance as it has been extracted already. Mainly volatile oil containing drugs like clove, coriander, fennel, caraway are adulterated by this method. As it is devoid of colour and taste due to extraction, natural colour and taste is manipulated with additives.

e) Substitution with Synthetic Chemicals to Enhance Natural Character:

Synthetic chemicals are used to enhance natural character of the exhausted drug. Examples: citral is added to citrus oils like lemon and orange oils.

Presence of Vegetative Matter of Same Plant:

Some miniature plants growing along with the medicinal plants are added due to their colour, odour, and constituents.

Harmful Adulterants:

Some are harmful materials as the adulterant, are collected from market waste materials and admixed with the drug. It is done for the liquid drugs.

Adulteration of Powders:

The drugs which are in the form of powders are frequently adulterated. Examples: dextrin is added in ipecacuanha, exhausted ginger in ginger, red sanders wood in capsicum powder and powdered bark adulterated with brick powder.

Reasons of Adulteration

a) Confusion in Vernacular Names:

In *Ayurveda*, *Parpata* refers to *Fumaria parviflora* Lam. In *Siddha*, ‘*Parpadagam*’ refers to *Mollugo pentaphylla* Linn. 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 *M. pentaphylla* Linn. as *Parpatta/ Parpadagam* and the North Indian suppliers supply *F. parviflora* Lam.. These two can be easily identified by the presence of pale yellow to mild brown colored, thin wiry stems and small simple leaves of *M. pentaphylla* Linn. and black to dark brown colored, digitate leaves with narrow segments of *F. parviflora* Lam.. *Casuarina equisetifolia* L. for *Tamarix indica* Willd. and *Aerva lanata* Juss. for *Bergenia ciliate* (Haw.) Sternb. are some other examples for adulterations due to confusion in names.

b) Lack of Knowledge about Authentic Source:

Nagakesar is one of the important drugs in *Ayurveda*. The authentic source is *Mesua ferrea* Linn. However, market samples are adulterated with flowers of *Calophyllum inophyllum* Linn. 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* Linn (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 substitution flowers they are single celled.¹⁶

c) Similarity in Morphology:

Mucuna pruriens Bek. is adulterated with other similar Papilionaceae seeds having similarity in morphology. *M. utilis* Wall. (sold as white variety) and *M. deeringiana* (Bort) Merr.(sold as bigger variety) are popular adulterants. Apart from this, *M. cochinchinensis* (Lour.) A. Chev., *Canavalia virosa* Roxb. and *C. ensiformis* (L.) DC. 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* (Bort) Merr. and *M. utilis* Wall. are bigger (1.5-2 cm) in size. While *M. deeringiana* (Bort) Merr. is dull black and *M. utilis* Wall. is white or buff colored.¹⁶

d) Lack of Authentic Plant:

Hypericum perforatum L. is cultivated and sold in European markets. In India, availability of this species is very limited. However, the abundant Indo-Nepal species *H. patulum* Thunb., sold in the name of *H. perforatum* L.. Market sample is a whole plant with flowers and it is easy to identify them taxonomically. Anatomically, transverse section of *H. perforatum* L. stem has compressed thin phloem, hollow pith and absence of calcium oxalate crystals. Whereas *H. patulum* Thunb. has broader phloem, partially hollow pith and presence of calcium oxalate crystals.¹⁶

e) 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-timber forest product (NTFP) contractors, in the past, roots of *Ventilago madraspatana* Gaertn. 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* (Royle) Johnston is the present source. Similarity is in yielding a red dye, *A. euchroma* (Royle) Johnston substitutes *V. madraspatana* Gaertn.. Recently *V. madraspatana* Gaertn. is not found in market. Whatever is available in the market, in the name of *Ratanjot* is originated from *A. euchroma* (Royle) Johnston.

f) Careless Collections:

Some of the herbal adulterations are due to the carelessness of herbal collectors and suppliers. *Parmelia perlata* Ach.

is used in Ayurveda, Unani and Siddha. It is also used as grocery. Market samples showed it to be admixed with other species [*P. perforate* (Jacq.) Ach. and *P. cirrhata* Fr.]. Sometimes, *Usnea* sp. is also mixed with them. Authentic plants can be identified by their thallus nature.¹⁶

Need for Substitution^{16,17,18,19}

Non-availability of the drug: Substitution for *Ashtavarga Dravyas* (group of 8 crude drugs). Uncertain identity of the drug: For the herb *Lakshmana* different species such as *Arlia quinquefolia* (L.) Decne & Planch., *Ipomea sepiaria* Koenig ex Roxb. etc are considered.

Cost of the drug: *Kumkuma* being costly herb is substituted by *Kusumbha* Geographical distribution of the drug: *Rasna* (*Pluchea lanceolata* Oliver & Hiern.) is used in Northern India while in southern parts *Alpinia galangal* (L.) Willd. is considered as the source.

The adverse reaction of the drug: *Vasa* is a well known *Rakta-Pittahara* (cures bleeding disorder) drug, but due to its abortifacient activity its utility in pregnant women is limited, instead drugs such as *Laksha*, *Ashoka* etc are substituted. **Table 1:** Commonly used substitution in Ayurveda drugs^{20,21,22}

Types of Substitution

a) Using Totally Different Drug:

Bharangi [*Clerodendron indicum* (Linn.) Kuntze] and *Kantakari*. *Bharangi* has bitter taste; *laghu* (light), *ruksha* (unctuous) *guna* (quality) and has *Kapha-vatahara* property. While *Kantakari* (*Solanum xanthocarpam* Schrad. & Wendl.) has *katu vipaka* (pungent in digestion) and *ushna virya* (hot potency). It has glycosides named verbascoside and solasonin, solamargin, solasurine respectively. Both *C. indicum* (Linn.) Kuntze and *S. xanthocarpam* Schrad. & Wendl. have shown antihistaminic activity. Both *C.indicum*(Linn.) Kuntze and *S.xanthocarpam* Schrad. & Wendl. are commonly used in the diseases related to the respiratory system, which are usually associated with release of histamines and other autacoids.²²

b) Substitution of the Species Belonging to Same Family:

Datura metel Linn. and *Datura stramonium* Linn. can be considered here. Chemical constituents are alkaloids, scopalamine, atropin, hyocyanin, lyoscine. The alkaloids are proved as bronchodilator and inhibitor of secretion of mucous membrane. The alcoholic extract of *D. metel* Linn. shows anthelmintic activity The alkaloid present in both the species are well proven bronchodilators and 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. metel* Linn. And *D. stramonium* Linn. are beneficial, while as *D. metel* Linn. would be a better choice as it is a proven anthelmintic.²²

c) Using Different Parts of the Plant:

The root of *Sida cordifolia* Linn. and the whole plant of *Sida cordifolia* Linn. can be considered. Root has the chemical constituents such as sitoindoside, acylsteryglycoside, while the whole plant has alkaloid, hydrocarbons, fatty acids and ephedrine.²² Various extracts of the whole plant showed anti- bacterial, antioxidant, hypoglycemic, hepatoprotective and cardio tonic activities. Though it is the root which is mentioned as officinal part of *S. cordifolia* Linn. in the classics as *Balya* (promotes strength), *Shothahara* (reduce inflammation) etc. Modern researches prove that even the aerial parts are also equally effective.²²

d) Due to Same in Action:

Embllica officinalis Gaertn. shows antioxidant, hepatoprotective, antimicrobial, hypoglycemic and hypolipidemic action. *Semecarpus anacardium* Linn. f. shows anti-tumor, hypotensive, anticytotoxic and anticancerous properties etc.²² 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.²³

Adulteration of Money Earning:^{24,25}

- Use of *Lavanga Kandi* (stem), *Lavanga Patra* (Leaf) for adulteration in *Lavanga* (flowering Bud) (*Syzygium aromaticum* (Linn.).
- Use of *Bada Gokushru* (*Pedaliium murex* Linn.) for adulteration in *Gokushru* (*Tribulus terrestris* (Linn.).
- Use of *Ela* (*Elettaria cardamomum* Mantom) seed coat (*chilka*) for adulteration in *Ela* seed.
- Use of *Kali jeeri* (*Centratherrum anthelminticum* Kuntze) for adulteration in *Kala jeera* (*Carum carvi* Linn.).
- Use of *Kismis* for adulteration in *Munakka* (*Vitis vinifera* Linn).
- Use of *Gunja* Root (*Abrus precatorius* Linn.) for adulteration in *Madhuyasthi* Root (*Glycyrrhiza glabra* Linn).
- Use of *Kustha* (*Saussrea lappa* C.B.Clarke) for adulteration in *Tagar* (*Valeriana wallichii* DC).

- Use of *Mustak* (*Cyperus rotundus* Linn.) for adulteration in *Ativisha* (*Aconitum heterophyllum* Wall.).
- Use of *Shatavari* (*Asparagus racemosus* Willd.) for adulteration in *Musali* (*Asparagus adscendens* Roxb.)

RESULTS

The market is flooded with adulterated and substituted drugs these days. There are different types of Adulterants viz. substandard, inferior, artificial or exhausted drugs. In addition to this, there are synthetic chemicals to enhance Natural Character, vegetative matter of the same plant. Some adulterants are harmful too. Adulteration of powders is the most common. There are many reasons of Adulteration viz. confusion in Vernacular Names, lack of Knowledge about Authentic Source, similarity in morphology, lack of authentic plant, similarity in color, careless collections, etc. Mostly adulteration is done for money earning. Sometimes substitution is the need of the situation due to non-availability of the original drug. There are various types of Substitution viz. using totally different drug, substitution of the species belonging to same family, using different parts of the plant, due to same in action.

DISCUSSION & CONCLUSION

Substitution of the herbs is the need of the hour with more than 300 medicinal plants becoming red listed. The most essential criteria for substitution is the pharmacological activity rather than morphology or phytoconstituents. Substitution of herbs achieved many goals though basic idea was to provide similar therapeutic effect as that of original drug. It provided a 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. Major reasons are confusion in name, non-availability and lack of knowledge about authentic plant. 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. All adulterations are intentional malpractices. Major reasons have been listed. Intentional substitution to decrease the cost and earn more profit for survival in market against large Ayurvedic pharma company. With the help of this thorough review, it is clear that with few basic identification points, one can easily differentiate between adulterated and original drug. Hence, the dealers and handlers of drugs should be made aware of these through training programmes.

Acknowledgements- Nil

Conflict of Interest – None

Source of Finance & Support - Nil

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How to cite this article: Rathore BS, Kotecha M, Chaudhary K, Manjula “Adulteration And Substitution In Indian Medicinal Plants: A Review Article” IRJAY.[online]2022;5(5);72-78.
Available from: <https://irjay.com>
DOI link- <https://doi.org/10.47223/IRJAY.2022.5512>

Table 1: Commonly used substitution in *Ayurveda* drugs^{20,21,22}

S. No.	Common name	Botanical name	Substitute drug	Botanical name
1	Chitrak	<i>Plumbago zeylanica</i> Linn.	Danti	<i>Baliospermum montanum</i> Muell. Arg.
2	Murva	<i>Marsdenia Tenacissima</i> W. & A.	Jinghini	<i>Lannea coromandelica</i> (Houtt.) Merr.
3	Bakula	<i>Mimusops elengi</i> Linn.	Kamala	<i>Nelumbo nucifera</i> Gaertn.
4	Tagar	<i>Valeriana wallichii</i> DC.	Kustha	<i>Saussurea lappa</i> C. B. Clarke
5	Jatipatra (Aril)	<i>Myristica fragrans</i> Houtt.	Lavanga	<i>Syzigium aromaticum</i> (Linn.) Merr. & L. M. Perry
			Jatiphala (fruits)	<i>Myristica fragrans</i> Houtt.
6	Puskar - mool	<i>Inula racemosa</i> Hook. f.	Kustha	<i>Saussurea lappa</i> C. B. Clarke
			Eranda (root)	<i>Ricinus communis</i> Linn.
7	Chavya	<i>Piper chaba</i> Hunter	Pippali (root)	<i>Piper longum</i> Linn.
8	Draksha	<i>Vitis vinifera</i> Linn.	Kashmari phala	<i>Gmelina arborea</i> Linn.
9	Bharangi	<i>Clerodendrum Serratum</i> spreng.	Kantakari	<i>Solanum xanthocarpum</i> Schrud. & Wendl.
10	Dhanavayasa	<i>Fagonia cretica</i> L.	Duralabha	<i>Alhagi pseudalhagi</i> (Bieb.) Desv.
11	Ahimsa	<i>Capparis sepiaria</i> L.	Manakanda	<i>Alocasia indica</i> (Roxb.) Schott.
12	Bakula (bark)	<i>Mimusops elengi</i> Linn.	Babul (bark)	<i>Acacia Arabica</i> Willd.
13	Tulasi	<i>Ocimum sanctum</i> Linn.	Nirgundi	<i>Vitex negundo</i> Linn.
14	Riddhi and Vriddhi	<i>Habenaria sp.</i>	Varahikanda	<i>Dioscorea bulbifera</i> Linn.
15	Ikshu	<i>Saccharum Officinarum</i> L.	Nala	<i>Arundo donax</i> Linn.
16	Kakoli	<i>Lilium polyphyllum</i> D. Don.	Asvagandha	<i>Withania somnifera</i> Dunal
17	Kshirakakoli	<i>Fritillaria roylei</i> Hook.	Asvagandha	<i>Withania somnifera</i> Dunal
18	Bhallataka	<i>Semecarpus anacardium</i> Linn. f.	Nadi Bhallataka	<i>Semecarpus travancorica</i> Beddome
19	Ativisha	<i>Aconitum</i>	Mustaka	<i>Cyperus rotundus</i> L.

		<i>Heterophyllum</i> Wall.		
20	<i>Dadima</i>	<i>Punica granatum</i> Linn.	<i>Vrikshamla</i>	<i>Garcinia indica</i> Chois.
21	<i>Karpura</i>	<i>Cinnamomum camphora</i> Nees & Eberm.	<i>Granthi parna</i>	<i>Leonotis nepetafolia</i> (L.) R. Br.
22	<i>Nagapuspa</i>	<i>Mesua ferrea</i> Linn.	<i>Padma kesar</i>	<i>Nelumbo nucifera</i> Gaertn.
23	<i>Kusha</i>	<i>Desmostachya</i> <i>Bipinnata</i> (L.) Stapf	<i>Kasha</i>	<i>Saccharum</i> <i>spontaneum</i> Linn.
24	<i>Kutherika</i>	<i>Ocimum basilicum</i> Linn.	<i>Gramya tulasi</i>	<i>Ocimum sanctum</i> Linn.
25	<i>Amlavetas</i>	<i>Garcinia pedunculata</i> Roxb.	<i>Chukra</i>	<i>Garcinia indica</i> Chois.