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Adulteration and Substitution in Indian Medicinal Plants: An Overview

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Ayurveda is a system of Indian traditional form of alternative medicine. In 20th and 21 century due to side effects of synthetic drugs, there is an increasing interest in Ayurvedic proprietary medicines. At present the adulteration and Substitution of the herbal drugs is the burning problem in herbal industry and it has caused a major advancement in the research on commercial natural products. The deforestation and extinction of many species and incorrect identification of many plants has resulted in adulteration and substitution of raw drugs. The future development of analysis of herbs is largely 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.

Keyword: Adulteration, Substitution, Indian Medicinal Plants, Ayurveda.

1. Introduction

Adulteration it 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].

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^[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^[1]. Due to adulteration, faith in herbal drugs has declined^[4].

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 herb, but rather due to the presence of an unintended herb^[13]. 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].

1. Types of Adulterants^[1]

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

1.1 Substitution with substandard commercial varieties:

Adulterants resemble the original crude drug morphologically, chemically, therapeutically but are sub standard in nature and cheaper in cost. This is the most common type of adulteration.

1.2 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.

1.3 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.

1.4 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.

1.5 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.

1.6 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.

1.7 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.

1.8 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.

2. Reason of Adulteration

2.1 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 *Berginia ciliate* are some other example for adulterations due to confusion in names^[16].

2.2 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 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^[16].

2.3 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^[16].

2.4 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^[16].

2.5 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 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. euchroma*^[16].

2.6 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^[16].

3. Need for Substitution^[16,17,18]

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*, *Ipomea sepiaria* etc are considered. Cost of the drug: Kumkuma being costly herb is substituted by Kusumbha. Geographical distribution of the drug: Rasna (*Pluchea lanceolata*) is used in Northern India while in southern parts *Alpinia galanga* 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 abortifaciant activity its utility in pregnant women is limited, instead drugs such as Laksha, Ashoka etc are substituted.

Table 1: Commonly use substitution in Ayurvedic drug^[20-22]

Sl. No.	Common name	Botanical name	Substitute drug	Botanical name
1.	Chitrak	<i>Plumbago zeylanica</i>	Danti	<i>Baliospermum montanum</i>
2.	Murva	<i>Marsdenia tenacissima</i>	Jinghini	<i>Lannea coromandelica</i>
3.	Bakula	<i>Mimusops elengi</i>	Kamala	<i>Nelumbo nucifera</i>
4.	Tagar	<i>Valeriana wallichii</i>	Kustha	<i>Saussrea lappa</i>
5.	Jatipatra (Aril)	<i>Myristica fragrans</i>	Lavanga	<i>Syzigium aromaticum</i>
			Jatiphala (fruits)	<i>Myristica fragrans</i>
6.	Puskar mool	<i>Inula racemosa</i>	Kustha	<i>Saussrea lappa</i>
			Eranda (root)	<i>Ricinus communis</i>
7.	Chavya	<i>Piper chaba</i>	Pippali (root)	<i>Piper longum</i>
8.	Draksha	<i>Vitis vinifera</i>	Kashmari phala	<i>Gmelina arborea</i>
9.	Bharangi	<i>Clerodendrum serratum</i>	Kantakari	<i>Solanum xanthocarpum</i>
10.	Dhanavayasa	<i>Fagonia cretica</i>	Duralabha	<i>Alhagi pseudalhagi</i>
11.	Ahimsa	<i>Capparis sepiaria</i>	Manakanda	<i>Alocasia indica</i>
12.	Bakula (bark)	<i>Mimusops elengi</i>	Babul (bark)	<i>Acacia arabica</i>
13.	Tulasi	<i>Ocimum sanctum</i>	Nirgundi	<i>Vitex negundo</i>
14.	Riddhi and Vriddhi	<i>Hobenaria spp.</i>	Varahikanda	<i>Dioscorea bulbifera</i>
15.	Ikshu	<i>Saccharum officinarum</i>	Nala	<i>Arundo donax</i>
16.	Kakoli	<i>Lilium polyphyllum</i>	Asvagandha	<i>Withania somnifera</i>
17.	Kshirakakoli	<i>Fritillaria roylei</i>	Asvagandha	<i>Withania somnifera</i>
18.	Bhallataka	<i>Semecarpus anacardium</i>	Nadi Bhallataka	<i>Semecarpus travancorica</i>
19.	Ativisha	<i>Aconitum heterophyllum</i>	Mustaka	<i>Cyperus rotundus</i>
20.	Dadim	<i>Punica granatum</i>	Vrikshamla	<i>Garcinia indica</i>
21.	Karpua	<i>Cinnamomum camphora</i>	Granthi parna	<i>Leonotis nepetafolia</i>
22.	Nagapuspa	<i>Mesua ferrea</i>	Padma kesar	<i>Nelumbo nucifera</i>
23.	Kusha	<i>Desmostachya bipinnata</i>	Kasha	<i>Saccharum spontaneum</i>
24.	Kutherika	<i>Ocimum basilicum</i>	Gramya tulasi	<i>Ocimum sanctum</i>
25.	Amlavetas	<i>Garcinia pedunculata</i>	Chukra	<i>Garcinia indica</i>

4. Types of Substitution:

4.1 Using Totally Different Drug:

Bharangi (*Clerodendron indicum*) and Kantakari. Bharangi has bitter taste; laghu (light), ruksha (unctuous) guna (quality) and has Kapha-vatahara property. While Kantakari (*Solanum xanthocarpum*) has katu vipaka (punjent digestion) and ushna virya (hot potency). It has glycosides named verbascoside and solasonin,

solamargin, solasurine respectively. Both *C. indicum* and *S. xanthocarpum* have shown antihistaminic activity. Both *C. indicum* and *S. xanthocarpum* are commonly used in the diseases related to the respiratory system, which are usually associated with release of histamines and other autacoids^[22].

4.2 Substitution of the Species Belonging to Same Family:

The *Datura metal* and *Datura stramonium* can be considered here. Chemical constituents are alkaloids, scopolamine, atropin, hyocyanin, lyoscine.

The alkaloids are proved as bronchodilatory and inhibitor of secretion of mucous membrane. The alcoholic extract of *D. metal* shows anthelmintic 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 *D. metal* would be a better choice as it is a proven anthelmintic^[22].

4.3 Using Different Species:

Two types of Gokshura viz. *Tribulus terrestris* (Zygophyllaceae) and *Pedaliium murex* (Pedaliaceae) of which, *T. terrestris* has the chemical constituents like chlorogenin, diosgenin, rutin, rhamnose and alkaloids. While *P. murex* has sitosterol, ursolic acid, vanilin, flavonoids and alkaloids. Both the species are proved for nephroprotective, lithotriptic, diuretic and hepatoprotective activities. The clinical conditions where Gokshura is indicated i.e., *Mutrakrcra* (renal disorder), *Ashmari* (urinary calculi), *Prameha* (diabetes) etc, both *T. terrestris* and *P. murex* appear to be appropriate^[22].

4.4 Using Different Parts of the 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 and ephedrine. Various extracts of the whole plant showed antibacterial, antioxidant, hypoglycemic, hepatoprotective and cardio tonic activities. Though it is the root which is mentioned as officinal part of *S. cordifolia* in the classics as *Balya* (promotes strength), *Shotahara* (reduce inflammation) etc. Modern researches prove that even the aerial parts are also equally effective^[22].

4.5 Due to Same in Action:

Embelica officinalis shows antioxidant, 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^[22].

5. 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.

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