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Adulteration & Substitution: An Interrupted and Non-interrupted Practices in Medicinal Plants in Ambiguous Herbal World

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ABSTRACT

In India approximately 80% tribal population depends on herbal medicines for their health and proper care to cure disease at first primary level. Generally, these herbal medicines are classified into five different classes. Now a days people are not more worried about Ayurvedic medicines therefore Ayurvedic practitioners become busy professionals like other modern practitioners because preparation of their own medicines requires so much time and its processing is hard enough for patients as well as their family members also. Substitution of Ayurvedic medicines is carried out therefore is carried out Ayurvedic medicines are facing number of problems for different purposes. Ambiguous medicinal plants are those plants which are described very well in classes of Ayurvedic ancient medicines in a well manner but their identification is not yet clear. Based on book related survey these plants are identified and defined by many names. Sometimes one common name is given to two or more than two medicinal plants. Substitution and adulteration are activities that are most often seen in herbal businesses. Aim of these practices is mainly found in many large or small commercial firms include Worst mixing with other plant raw materials, substitution, addition with great skill, loss of medicinal properties of main drug. Now a day's substitution and adulteration is extremely important step in herbal businesses. Therefore there is need for proper methods for their right medicinal plants and herbal medicines.

Keywords: Substitution, Adulteration, Ambiguity and Ambiguous plants/Drugs, Substituted plants.

INTRODUCTION

In Ayurveda more than 8000 medicines including single drug and combination of other compound herbal drugs is talked about. Generally these Drugs are classified into five different classes. Biological living species are identified traditionally according to their shape and structure which are known as morphological features. These Morphological keys are yet the main basis of taxonomical classification. In the case when morphological features of a specimen are lacking, it becomes very hard even for a specialists to recognize a species. Authentication using DNA barcodes overcomes these problems [4]. In India large and medium commercial firms are there. Among them 14 are large scale and 86 are medium scale commercial manufacturers.

CLASSIFICATION OF DRUGS

1. Scientifically studied Drugs
2. Famous non-toxic drugs
3. Efficient but toxic Drugs
4. Drugs which are very less in use
5. Hereditary Drugs and drugs used for Patients

1. Scientifically studied Drugs

Some single Drugs like '*Sarpa gandha*' and '*Curcumin*' have been studied scientifically and their therapeutic uses have been proved. *Sarpa gandha* is useful in high blood pressure and *Curcumin* is useful in healing of inflammation. *Guggulu* is useful in rheumatism. Gum Resin of *Guggulu* is important component for many medicines.

2. Famous non-toxic Drugs

Some drugs are very much famous for their therapeutic use among human population. These Drugs are

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non-toxic in nature. Such types of medicines are 'Chyawanprash' and 'Arjunaristha'. Important ingredient of Chyawanprash is Amalaki which is useful in chronic diseases of lungs and chronic bronchitis. Important ingredient of Arjunaristha is Arjuna which is useful in treatment of hypotension and hypertension [1].

3. Efficient but toxic drugs

Some Drugs like 'Bhallataka', 'Tambul' and 'Nithyakalyani' which have been used for their medicinal properties, but they also produce severe toxicity if used for longer time. Bhallataka is used in skin disorders. More use of Nithyakalyani produce nausea, vomiting and other symptoms related to stomach and intestine. More use of Tambul leads to dysuria [1].

4. Drugs which are very less in use

Some drugs for example 'Vishnu taila' is very less in demand because it is used only in certain parts on India. Aavari is also very less in use [1].

5. Hereditary Drugs and drugs used for Patients

Sometimes health officers are specialized in treatment of certain diseases. The formula and methods of these drugs are known only to them or to some trustworthily family members. Some drugs are not as effective as they proved but some other drugs are found to be very much effective. In most of cases health officers are not all willing to disclose the formula and even if they give consent, it is associated with a demand for heavy financial compensation [1].

ANCIENT AYURVEDIC PRACTICES:

In older Days medical practitioner was very least consulted for minor disorders because older members of family were well familiar with the use of herbs for treatment of such disorders. At that time the role of medical practitioner was only to guide their family members for proper collection of plants and process them properly and to guide them for proper diet during ongoing treatment. So only serious cases needed their supervision and in that case they needed to prepare their own medicines. Things have been changed now. They are approached for even minor disorders. Now a days people are not more concerned about Ayurvedic medicines therefore ayurvedic practitioners become busy practitioners like other modern practitioners because preparation of own medicines require so much time and its processing is hard enough for patients as well as their family members also. As result of this some well known and big commercial agencies which supply Ayurvedic medicines are facings number of problems. These problems are as follows:

Problems faced by commercial firms

1. Collection of premature herbs
2. Improper processing and preservation
3. Methods of preparation
4. Use of substituted drugs
5. Substitution of costly drugs
6. Omission of Ingredients

1. Collection of premature herbs

For medicinal purposes different parts of medicinal plants are required which arecollected during specific period of time. Annual plants are

collected before ripening of seeds. Biennial plants are collected during season of spring and perennial plants are collected during season of autumn. Some plant fruits are collected only when they are fully ripened like 'Amlaki'. Stick of the plant is collected during the first year of its growth. Barks and roots are collected during hot, rainy as well as cold seasons. These informations are followed by large commercial agencies during collection of plants [1].

2. Improper processing and preservation

Raw materials of drugs are stored for some time before processing. Proper care is needed during packaging of these raw materials because during this procedure there are chances of loss of some important active ingredient compound from these raw materials.

3. Methods of preparation

Various methods are described for preparation of ayurvedic drugs. Some of methods are time consuming and need skilled labour where as some methods are. not so much costly. Therefore for these reason some companies follow less costly methods and develop their own less costly methods for preparation of such drugs but drugs prepared by these methods are not guaranteed to be as much effective as they are prepared by these less cost effective methods. Therefore due to these problems sometimes medical practitioners are not sure about effectiveness of drugs to which they prescribed [1].

4. Use of substituted drugs

Some drugs which have important medicinal uses like 'Jyotishmati', 'Yasti madhu' and 'Jatamansi' are often substituted and adulterated and sold in market with cheaper prize. Ayurvedic practitioners and commercial agencies are also supplied with these adulterated materials and consumers are also facing such kind of problems.

5. Substitution of costly drugs

In some cases main substituent of some costly drugs are prescribed. For example 'Satavari' is used in place of 'Musali' and 'Atibala' used in place of 'Dudhiyakalmi'. 'Jatamani' is substituted with 'Tagar' and 'Bhutkeshi'.

6. Omission of Ingredients

Generally compound preparations are used in ayurvedic medicines. These compound preparations are total effect of all individual drugs which plays an important therapeutic role. These ingredients are served for following purposes:

PURPOSES

1. Synergistic Action

Synergistic action is the combined or cumulative action of all individual active ingredients of drug. 'Trina panchmool kwath' is example of synergistic action. Combined action of ingredients like 'Kusha', 'Kasha', 'Shara', 'Darbha', 'Ikshu' is used in urine related disorders(as diuretics).It means each ingredient is used as diuretics but when all ingredients are together they produce their synergistic effect.

2. Combined Action

Madhunasini vati is used in the treatment of diabetes. For curing diabetes this medicine should have anti-diabetic, neuroprotective, cardio protective, antioxidant and adaptogenic action.

3. Neutralizing toxicity

Anantmul is example of neutralizing drug. If high dosage of *Kupilu* will be taken then it will cause trouble to human body therefore *Kupilu* is not taken alone but it is first purified by procedure mentioned in 'Sodhana' and then it is taken with other drugs to decrease its toxic effect [1].

4. Specific action

'Medhyarasayana' and 'Chyavanaprash' are example of specific action drugs. In the preparation of *Chyavanaprash Pippali* is added by heat treatment which has anti-tubercular effect. To decrease heating effect of *Pippali* cooling effect of *Amlaki* is given [1].

5. Improper storage

This class includes various types of drugs which are effective for certain limited period of time but they lose their potency if they are used for longer period of time. Drugs prepared by manufacturers are not used immediately after their production but there is huge time gap before this drug is really used by patients.

By remembering above points many formulas have been described for medicinal preparations. Due to some reasons like if any of ingredients is not available at time or it is too much costly then preparation of formulation without them not only decreases potency of drug but it will create harmful effects also.

The estimated current annual production of herbal drugs is around Rs. 3500 crores. There is great opportunity sector for Indian trade and commerce in the field of pharmaceuticals, nutraceutical, cosmetics and other products due to the increased demand of medicinal plants [6]. The traditional system of medicine implements medicinal plants to cure various diseases, however herbal industry undergoes from substitution and adulteration of medicinal herbs with closely related species.

TRANSITION OF TWO SIDES OF COINS IN AYURVEDA-SUBSTITUTION AND ADULTERATION:

Abiguity And Abiguous Plants

Ambiguous medicinal plants are those plants which are described very well in classes of Ayurvedic drugs in a well manner but their identification is not yet clear. Based on literature survey these plants are identified by many names. Sometimes one common name is given to two or more than two medicinal plants. Therefore, such type of ambiguity in identification of ambiguous medicinal plants creates trouble sometimes. There are many medicinal plants found which has still ambiguous identity. *Amarvel* that is common name of medicinal plants *Cuscuta reflexa* and *C. chinensis*.

Table 1: List of Ambiguous medicinal plants in which mostly Ambiguity is found.

Common name of ambiguous medicinal plant	Botanical name of medicinal plants that often finds ambiguity
<i>Shankpushpi</i>	<ul style="list-style-type: none"> ➤ <i>Convolvulus microphyllus</i> ➤ <i>Convolvulus pluricilius</i> ➤ <i>Clitorea ternatea</i> ➤ <i>Evolvulus alsinoids</i>
<i>Amrvel</i>	<ul style="list-style-type: none"> ➤ <i>Cuscuta reflexa</i> ➤ <i>Cuscuta officinalis</i> ➤ <i>Cuscuta chinensis</i>
<i>Kumari</i>	<ul style="list-style-type: none"> ➤ <i>Aloe vera</i> ➤ <i>Aloe barbadensis</i> ➤ <i>Aloe chinensis</i>
<i>Bala</i>	<ul style="list-style-type: none"> ➤ <i>Abutilon indium</i> ➤ <i>Sida cordifolia</i> ➤ <i>Sida rhombifolia</i>
<i>Brahmi</i>	<ul style="list-style-type: none"> ➤ <i>Bacopa monnieri</i> ➤ <i>Centella asiatica</i> ➤ <i>Bacopa floribunda</i>
<i>Nagkesar</i>	<ul style="list-style-type: none"> ➤ <i>Messua ferrea</i> ➤ <i>Orchocarpus longifolius</i> ➤ <i>Calophyllum inophyllum</i> ➤ <i>Cinnamomum tamala</i> ➤ <i>Dillenia pentagyna</i>
<i>Pipali</i>	<ul style="list-style-type: none"> ➤ <i>Piper nigrum</i> ➤ <i>Piper retrofractum</i> ➤ <i>Piper chaba</i>
<i>Aakado</i>	<ul style="list-style-type: none"> ➤ <i>Calotropis procera</i> ➤ <i>Calotropis gigantea</i>
<i>Kantkari</i>	<ul style="list-style-type: none"> ➤ <i>Solanum virginianum</i> ➤ <i>Solanum xanthocarpum</i>
<i>Pashananbheda</i>	<ul style="list-style-type: none"> ➤ <i>Bergania lingulata</i> ➤ <i>Aerva javanica</i> ➤ <i>Brayophyllum pinnatum</i>
<i>Tulsi</i>	<ul style="list-style-type: none"> ➤ <i>Ocimum sanctum</i> ➤ <i>Ocimum tenuiflorum</i> ➤ <i>Ocimum americanum</i> ➤ <i>Ocimum gratissimum</i>

Table-1 shows list ambiguous medicinal plants which show ambiguity.

SUBSTITUTION IN MEDICINAL PLANTS

Substitution in medicinal plants is often faced by different commercial firms due to following reasons:

Reasons for substitution

1. Confusion in Vernacular Names
2. The deforestation and extinction of many species
3. Lack of Knowledge About Authentic Source
4. Similarity in Morphology
5. Similarity in Colour
6. Careless Collections
7. Need for Substitution

1. Confusion in Vernacular names:

People of India did ethnobotanical and ethnomedical practices for practical documentation of medicinal plants. Various experts like Indian hakims and vaidyas were involved in this work. That was pre Linnaean period and at that time there was not pre existing system present for proper classification naming and botanical documentation of medicinal plants. For an example in the 17th century *Hortus malabaricus* was written in 794 different interpretations along with pronunciation of each individual plant in Latin and its name in four scripts [2]. But only names don't give identity. Identity needs detailed morphological interpretation that is mentioned in ayurvedic literatures. Only such plants like 'Haridra' and 'Tulsi' which have been actively used since ancient time have not controversy in their names. Way to identify plants is to interact with traditional tribal living communities who have knowledge of these plants and have lifelong ancient survivor family members from them they get knowledge of these medicinal plants [2].

Because of similarity of in names mentioned in traditional medicines *Fumaria parviflora* which is commonly known as *Parpatta* and *Mollugo pentaphylla* which is commonly known as *Parpadagam* these two medicinal plants are often interchangeably substituted or adulterated. In the region of south India collectors supply *M.pentaphylla* as *Parpatta* /*Parpadagam*. In the region of north India collectors supply *F.parviflora* as *Parpatta/Parpadagam*. *M.pentaphylla* pale yellowish in colour, contains hairy stem, and small leaves. *F.parviflora* is dark brownish in colour and contains finger like leaves so called digitate leaves. *Tamarix indica* which is commonly known as *Amlika* often identified as *Casuarina equisetifolia* which is commonly known as *Aamrah* and *Bergenia ciliata* which is commonly known as *Pashanbheda* often identified as *Aerva lanata* which is commonly known as *Ashmabhedah* [3].

2. The deforestation and extinction of many species

Due to increasing horizons of industrialization and other anthropogenic activities like overexploitation some medicinally impotent medicinal plants lost their natural habitat. Among them deforestation is the main reason. In India especially in Western Ghats due to such kind of human activities some medicinal plants are become endangered now and some plants are in a threat to become extinct in near future. Among these medicinal plants *Karihari*, *Arkmul* and *Anatmool* are put in list of rare and endemic plant species of Western Ghats.

3. Lack of Knowledge about Authentic Source

Pushkarmool is one of the important drugs where as it is often adulterated with *Kuth* root. However, *Pushkarmool* is available in ample quantity in the region of Himachalpradesh, Uttarakhand and Kashmir of India. But sometimes people don't know about it and sometimes also such type of collection activities are not allowed in such areas. Because of these reasons *Kuth* root is sold as *Pushkarmool*.

Hypericum perforatum plant which is basically is not from Indian origin grown and sold in European countries. In India its availability is very less therefore *Hypericum petulum* is sold in place of *H.perforatum* in Indian market. If we see thin section of contains thin phloem, depressed pith and no calcium oxalate crystals where as thin section of

H. petulum contains thick phloem, partially depressed pith and presence of calcium oxalate crystals [3].

4. Similarity in Morphology

One of the good examples of similarity of morphology in medicinal plants is *Shankhpushpi*. Main plant of *Shankhpushpi* known as *Evolvulus alsinoids*. Flowers of *Shankhpushpi* are often substituted with flowers of *Convolvulus microphyllus* and *Convolvulus pluricolius* due to similarity in morphology of their roots and stems. Sometimes *Shankhpushpi* is also adulterated with *Aparajita* known as *Clitorea ternatea*.

5. Similarity in Colour

When certain time period passed well known plant material is changed or substituted with leaves and other plant materials. Best example of it is *Brahmi*. Leaves are collected from south and eastern part of India most prominently from Assam. But as present source *Nirbrahmi* is used which is known as *Bacoppa moniari* due to similarities in leaves *Bacoppa moniari* and *Hydrocotyl aciatica* are also used as present day source of *Brahmi*. So whatever is available in market right know that is actually originated from *Centella aciatica*.

Present Day example is *Jathropha curcas* which is commonly known as *Ratanjot*. As source of *Ratanjot* roots of *Ventilago madraspatana* were collected from region of Western Ghats which is commonly known as *Raktvali*. But present day source of *Ratanjot* is *Arnebia euchroma* which is commonly known as *Suvaha*. *V. madraspatana* is substituted with *A. euchroma*. So in present day in Indian market *A. euchroma* is available as *Ratanjot* [3].

6. Careless Collections

Due to careless collection by suppliers *Gugullu* is often mixed with *Babool*. *Parmelia perlata* which is commonly known as *Sitasiva* is useful as grocery and food stuffs. In market this plant species is mixed with *P. perforata* and *P. cirrhata* as *Sitasiva* [3].

7. Need for Substitution

Sometimes there is need for substitution due to several reasons. Main plant source is sometimes vary much costly and not available in all seasons and their collection procedure is so much time taking and also sometime they grow in restricted areas where collection is strictly prohibited. In those cases, plant that used as substituent species are easily available and not so much costly in prize. Most important their collection is not so much time taking. More or less medicinal properties of plants are not so much changed. So for such cases there is strong need for substitution.

NEED FOR SUBSTITUTION:

1. Individuality is not sure

Sometimes botanical individuality of medicinal plant is not emphasized properly so they are substituted easily. *Shankhpushpi* is example of it. Different species such like *Convolvulus pluricolius*, *C. microphyllus* and *Clitorea ternatia* are considered as *Shakhpushpi*.

2. Prize of Plant

Because of highly accurate environment during cultivation and proper processing sometimes medicinal plants are very much costly. In Indian market *Kesar* is very much rich in prize. *Crocus sativus* –*Saffron Kesar* that is often substituted with *Carthamus tinctorius* which is commonly known as *Kusumbha*.

3. Unfavorable reaction with drugs

Sometimes some medicinal plants are proven to be good in treatment of influenza, rheumatism and they also work as good blood purifier. Roots of *Ginger* and leaves of *Chitrag* are good in treatment of flue and cold. But use of *Zingiber officinalis* and *Plumbago zeylanica* is avoided during pregnancy period. They are giving with combination of other plants drugs.

Table 2: Medicinally important main plant substituted with other plant.

Main medicinal plant	Common name	Substituted plant	Common name
<i>Beliospermum monatum</i>	Danti	<i>Croton oblongifolius</i>	Nagdanti
<i>Celastrum peniculatus</i>	Jyotishma ti	<i>Cardiospermum helicacabum</i>	Kanfuti
<i>Abutilon indicum</i>	Atibala	<i>Ipobea alba</i>	Dudhiyakalmi
<i>Catunaregam spinosa</i>	Mindhal	<i>Gardenia turgida</i>	Karumba
<i>Messua ferrea</i>	Nagkesar	<i>Ochrocarpus longifolios</i>	Raktpuspa
<i>Piper chaba</i>	Pipali	<i>Piper retrofractum</i>	Pipali
<i>Cinnamomum camphora</i>	Kapur	<i>Leonotis nepetifolia</i>	Granthiparni
<i>Myristica fragrances</i>	Jatiphala	<i>syzygium aromaticum</i>	Lavang
<i>Inula racemosa</i>	Puskarmul	<i>Ricinus communis</i>	Arandi
<i>Braccica nigra</i>	Kalli raai	<i>Argimone maxica</i>	Brahmadandi
<i>Plumbago zeylanica</i>	Chitrag	<i>Beliospermum monatum</i>	Danti
<i>Ocimum basilicum</i>	Shyam tulsi	<i>Ocimum sanctum</i>	Tulsi
<i>Semecarpus anarcadium</i>	Bhallatak a	<i>Semecarpus travancoria</i>	Bhallataka
<i>Clerodendron serratum</i>	Bharangi	<i>Solanum xenthocarpum</i>	Kantakari
<i>Marsdenia tenacissima</i>	Murva	<i>Operculina turpethum</i>	Trivit
<i>Desmostachya bipinnata</i>	Kusha	<i>Saccharum spotanium</i>	Kasha
<i>Origanum vulgare</i>	Maruvaka	<i>Origanium majorana</i>	Murva
<i>Microstysis muscifera</i>	Rishbhaka	<i>Ipomoea digitata</i>	Vidari kanda
<i>Sena angustifolia</i>	Sonamukh i	<i>Cassia oftusifolia</i>	Kasundri
<i>Semecarpus anarcadium</i>	Bhallatak a	<i>Semecarpus travancoria</i>	Bhallataka
<i>Alhagi camelorum</i>	Yavasa	<i>Tragia involucrata</i>	Duralabha
<i>Caparis sepiaria</i>	Ahimsra	<i>Alocasia macrorrhiza</i>	Mankanda
<i>Psoralea corylifolia</i>	Somaraji	<i>Cassia tora</i>	Chkramada
<i>Jungle geranium</i>	Bandhuka	<i>Calophyllum inophyllum</i>	Punnaga
<i>Vitis venifera</i>	Draska	<i>Saussurea lappa</i>	Kashmiri
<i>Pinctada Margaritifera</i>	Mukta	<i>Pinctada Margaritifera -calyx</i>	Muktashakti

Table 2 shows list of main medicinal plant which are often substituted with other plants.

ADULTERATION

Adulteration refers to Substitution of main medicinal part with partially or totally different plant. In short adulteration is interrupted or none interrupted activity which is generally carried out by different commercial firms for their benefits [5]. Worst mixing with other plant raw materials, substitution, qualitative addition with great skill, loss of qualitative medicinal properties of main medicinal plant or drugs are procedures of Adulteration.

Worst mixing includes mixing of one substance to another purposefully and sometimes not intensely and such kind of practices is called admixing. In most often cases it is kind of careless and unintentional activity.

Qualitative addition with great skill is kind of activity which is done purposefully for financial benefits. Such practices are like gold coating which is done by jewelers but it is not real gold as such.

Loss of qualitative properties of main medicinal plant is because of bacterial, fungal and parasitic infection which also leads to adulteration.

Substitution and adulteration are connected with each other. If such kind of practices will be remain for longer period of time Individuality of real main medicinal plant will be in trouble. Due to similarity in morphology and similarity in medicinal uses mentioned in ancient Ayurvedic text is main reason for substitution. Such practices are sometimes problematic in standardization of herbal products and formulations.

Substitutions are carried out because sometimes authentic source plant is not available in time, deforestation of their natural habitats, seasonal variations, lack of knowledge about their proper cultivation.

Substitution and adulteration are unprofessional practices because of collectors and suppliers are not well trained. Therefore, to fix these problems to give better positions to person has helping hands and proper knowledge about fixing problems and who can generate standardization of authentic source based on their years hard work and should put in front line by providing them proper environment and chance for peaceful work.

World health organization (WHO) published quality standards for medicinal plants. According to these standards if any plant material is substituted or adulterated with more than 5% with other raw materials like other plant parts such as roots, stem, leaves etc., and then such plant material will be refused to maintain proper efficacy and safety in herbal commercial firms.

Based on these standards adulteration whether it is carried out purposefully or not will be refused. Proper awareness about knowledge of authentic source of medicinal plant material is given to local suppliers and collectors to decrease such kind of practices. Adulteration and substitution are major disadvantage in improvement of herbal drugs. So, for proper standardization, efficacy and potency of herbal drugs problems related substitution and adulteration of

medicinal plants should be solved. To maintain uniformity in selection and standardization of main herbal drugs Ayurvedic pharmacopeia of India (API) plays major important role.

Table 3: List of medicinal plants adulterated with other plants

Main medicinal plant	Common name	Adulterated plant	Common name
<i>Nardostachys jatamansi</i>	Jatamasi	<i>Valeriana wallichii</i> <i>Selinum vaginatum</i>	Tagar Bhutkeshi
<i>Messua ferrea</i>	Nagkesar	<i>Nilumbo nusifera</i>	Padmakesar
<i>Punica granatum</i>	Anar	<i>Garnicia indica</i>	Kokum
<i>Aconitum heterophyllum</i>	Ativisha	<i>Cyprus rotundus</i>	kuruvund
<i>Microstylis wallichii</i>	Jiivaka	<i>Tinospora cordifolia</i>	Guduchi
<i>Saccharum officinarum</i>	Iksu	<i>Arundo donax</i>	Dhamana
<i>Ipomea sepiaria</i>	Lakshmana	<i>Adiantum caudatum</i>	Mayursikha
<i>Mimusops elengi</i>	Bakula	<i>Vachellia nilotica</i>	Babool
<i>Coffea Arabica</i>	Kafi	<i>Tamarindus indica</i>	Amlika
<i>Commiphora myrrha</i>	Bol	<i>Commiphora wightii</i>	Gugullu
<i>Crocus sativus</i>	Kesar	<i>Carthamus tinctorius</i>	Kusumbha
<i>Anicostema axillari</i>	Mamejvo	<i>Parthenium hysterophorus</i>	Ghas

CONCLUSION

Both substitution and Adulteration are different set of terminologies. Majority of substitution and adulteration is carried out due to improper pharmaceutical activity rather than morphological similarity and difficulties in their individualities.

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Conflict of Interest

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