WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 13, Issue 6, 927-949. Review Article ISSN 2277–7105

A COMPREHENSIVE REVIEW ON ADULTERATION PRACTICES IN AYURVEDIC HERBAL CRUDE DRUGS

[*1] Dr. Minal Sunil Naik and [2] Dr. Prachi Nandwate

[1*]PG Scholar, Dravyaguna-vidnyan Department, Government Ayurvedic College, Dharashiv, Maharashtra – 413501.

[2]Guide, HOD and Assistant Professor Dravyaguna-vidnyan Department, Government Ayurvedic College, Dharashiv, Maharashtra – 413501.

Article Received on
12 March 2024,

Revised on 01 April 2024,
Accepted on 21 April 2024

DOI: 10.20959/wjpr20246-32188

***Corresponding Author**
Dr. Minal Sunil Naik
PG Scholar, Dravyaguna-vidnyan Department, Government Ayurvedic College, Dharashiv, Maharashtra – 413501.

ABSTRACT

Herbs are an effective source of Ayurvedic, traditional as well as modern medicine. Faced with the challenges of modern medicine, the world is shifting toward Ayurvedic theories of health management. India is having a rich flora and fauna and one of the richest biodiversity all over the globe. As the sources are very limited and population burden is high, the red list data and endangered plant species are increasing day by day in India. There is lots of estimation business of herbal drugs in India and all over the world. In the treatment of the disease, the use of drugs is not limited. This increases the demand for raw materials exponentially. Rapid depletion of resources creates major problems. To fill the deficit, advances in adulteration becoming more prevalent. This adulteration is a burning problem in an industry that threatens the integrity of Ayurvedic system of medicine. Therefore, an understanding of all ways of adulteration is needed to amend this illegal act and maximize consumer safety. This article focuses on adulteration in herbal medicine its types, methods, reasons and evaluation methods.

KEYWORDS: Adulteration, Ayurvedic herbal drugs, Evaluation methods.

❖ INTRODUCTION

Ayurveda is a system of Indian traditional form of alternative medicine. In 20th and 21th century due to side effects of synthetic drugs, there is an increasing interest in ASU medicine. At present the adulteration of the herbal drugs is the burning problem in ASU herbal industry

and it has caused a major problem 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.[1] The term adulteration is defined as substituting original crude drug partially or completely with other similar looking substances. The substance, which is mixed, is either free from or inferior in quality in terms of chemical and therapeutic properties.[2] In general, term adulteration is devaluation of any substance by adding or subtracting any things with the original substance which decrease the quality of that substance and may be injurious to health and may cause variety of adverse effects from mild, moderate to severe life threatened reactions. Adulteration is caused due to increased demand of medicinal plants. It has been studied in many reports that, the adverse drug reaction happens due to the presence of adulterants in it. So, understanding of all the methods of adulteration and its evaluation technique is necessary to rectify this illegal act and maximizing consumers safety and to elevate the research standards in Ayurveda. This adulteration may be intentional or unintentional. Intentional adulteration is criminal act and punishable offence under Section 274 (imprisonment for a term which may go up to six months, or with a fine which may extend to □ 1000, or with both.) The motive behind the Intentional adulteration is normally commercial one and originate mainly with the intention of enhancement of profits.

Current scenario of medicinal herbs[3]

- According to WHO, present demand for medicinal plants is $14 billion a year and by the year 2050 it would be $5 trillion.
- In India about 25,000 plant-based formulations are used in traditional and folk medicine. More than 1.5 million practitioners are using the traditional medicinal system.
- More than 7800 manufacturing units are involved in the production of natural health products, which requires more than 2000 tons of a medicinal plant raw material annually.

❖ MATERIAL AND METHODS

All Ayurvedic treaties including *samhitas*, lexicons, textbook and modern texts, publications are refereed for the information regarding Adulteration, its types, methods, reasons and evaluations methods.

Adulteration in Ayurveda[4]

Adulteration is termed as *Apamishrana* in Ayurveda. In ancient classics some artificially prepared *Dravyas lakshana* are mentioned:

For examples:

Karpura lakshanas

Acharya Narahari, Author of Raj Nighantu in *Chandanadi varga*, while mentioning *Prashastha karpura lakshana* says that, if the karpura is clear, light weight, *Tikta rasa yukta*, white, devoid of *Sneha* then regard it as *Shuddha* if not it is considered as *Krutrima karpura*.

Artificial *Kasturi lakshana*

Acharya Narahari, the author of Raj Nighantu in *Chandanadi varga* says that, artificial *Kasturi* smells like *Dhuma*, yellow colored after putting in *Payasa*, burn immediately in fire, heavy, *Ruksha* after Mardan.

Types of Adulteration[5]

Adulteration can be broadly classified into two types

A. Direct or Intentional Adulteration: Intentional adulteration is mainly encouraged by traders who are reluctant to pay premium prices for herbs of superior quality & hence are inclined to purchase only the cheaper products.
B. Indirect or Unintentional Adulteration: Occurs without bad intention of the manufacturers or suppliers. Some times in the absence of proper means of evaluation, an authentic drug partially or fully devoid of the active ingredients may enter the market.

Methods of Adulteration[6]

- Inferiority
- Spoilage
- Deterioration
- Admixture
- Sophistication
- Artificially Manufactured substance
- Using of Synthetic Drugs
- Harmful Adulterants

❖ **OBSERVATION AND RESULTS**

1. **INFERIORITY**: Any natural substandard drug containing chemical constituent less than the standard drug value. Selection of an herbal specie that contain same active constituent but lesser in amount.

➢ For example: a)Indian senna (*Cassia angustifolia*) leaves adulterated with Alexandrian senna (*Cassia acutifolia*) leaves.

b) *Strychnos nux-vomica* seeds adulterated with *Strychons potatorum* seeds (*Nirmali beej*)

Image 1: *C. angustifolia (Swarnpatri)* and *C. acutifolia leaves.*

Image 2: *S. nux-vomica (Kuchala)* and *S. potatorum seeds (Nirmali beej).*

2. **SPOILAGE**: A process in which the quality or value of drug has been impaired and destroyed by action of fungi and bacteria as to render the article unfit for human consumption.

➢ For example: • *Vacha* rhizome and *Ativsha* roots

Image 3: Authentic and Spoiled Vacha rhizome.

4: Authentic and Spoiled Ativisha Roots.

3. **DETERIORATION**: Impairment in quality or value of drug due to some physical processes e.g. distillation, extraction, moisture, heat resulting in destruction of its valuable constituent.

➢ For example: • Mainly volatile oil containing drugs like *Jiraka, Lavanga, Dhanyaka.*

Image 5: *Jiraka* (*Cuminum cyminum*)

Image 6: *Lavanga* (*Syzygium aromaticum*)

Image 7*: Dhanyaka* (*Coriandrum sativum*)

4. **ADMIXTURE**: Addition of one substance to another through accident, ignorance or carelessness. A part of same plant which is devoid of therapeutic action is mixed.

➢ For Example: a) Stem/leaf portions are mixed with roots like - *Dashmool,*

b) Inclusion of soil and stone pieces in *Hingu, Guggulu, Mochrasa* with adhering soil and other plant parts.

c) Clove is mixed along with petioles.

Image 8: *Lavanga* mixed with Petioles.

5. **SOPHISTICATION**: Addition of spurious or inferior material to an article with an intent to defraud. The drugs which are in the form of powders are frequently adulterated by this method.

➢ For Example: a) Addition of wheat flour to powdered ginger.

b) Addition of potato starch to *Guduchi sattva.*

Image 9: Shunthi Churna with wheat flour.

Image 10: Add. of potato starch to Guduchi sattva.

6. **Artificially Manufactured Substances**: The drug is adulterated with substance which has been prepared artificially.

➢ For Examples: a) Properly cut, shaved Basswood – For nutmeg

b) Yellow coloured paraffin wax for Bees wax

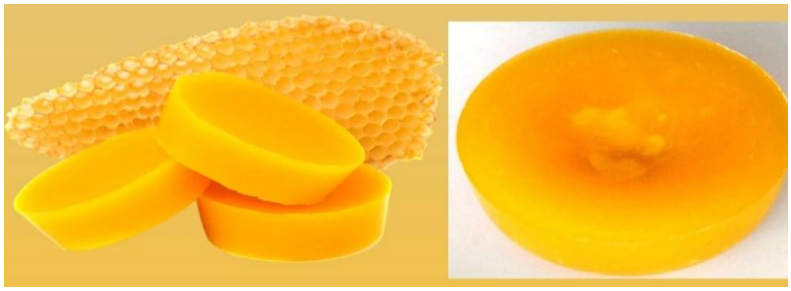

Image 11: Yellow coloured paraffin wax for Bees Wax.

7. **Using of Synthetic Drugs:** Synthetic chemicals are used to enhance natural character.

➢ For Example: Citral is added to citrus oils

8. **Harmful Adulterants**: Sometimes waste from the market is collected and admixed with the authentic drug.

➢ For Example: a) Limestone in Asafoetida

b) Mentanil Yellow in Turmeric powder

c) Addition of rodent faecal matter in Cardamom seed

d) Argemone seed in Mustard seed

Image 12: Turmeric and Mentanil Yellow.

Image 13: Mustard Seed and Argemone Seed.

❖ **Reasons of Adulteration**

Know about the different causes due to which adulteration of crude drugs occur

Two main types for reasons of adulteration are:

I. **Unintentional or Indirect Adulteration**

II. **Intentional or Direct Adulteration**

- **Confusion in vernacular name -** Because of the confusion in vernacular names, there occurs adulteration with other drugs. In Ayurveda, ‘Amruta’ is common synonym of *Guduchi* (*Tinospora cordifolia*), *Haritaki* (*Terminalia chebula*) and *Amalaki* (*Emblica officinalis*).



Image 14: *Guduchi* (*Tinospora cordifolia*) **Haritaki (*Terminalia chebula*)** **Amalaki (*Emblica officinalis*)**

- **Lack of knowledge about authentic source** - *Nagakesara (Mesua ferrea)* market samples are adulterated with flowers of *Punnaga* (*Calophyllum inophyllum*). Adulterated flowers are identified by presence of two celled ovary, but the original flowers with single ovary.


Image 15. *Nagakesara (Mesua ferrea)* and *Punnaga (Calophyllum inophyllum)*.

- **Similarity in Morphology** - *Mucuna pruriens* adultered with, other similar papilonaceae seeds like *Mucuna utilis* (White variety) & *Mucuna deeringiana* (Bigger variety). Authentic seeds are up to one cm in length with shinning mosaic pattern of black or brown colour on their surface.

Image 16: *Kappikachu (Mucuna pruriens), Mucuna deeringiana* (Bigger variety) *Mucuna utilis* (White variety).

- **Adulteration based on drug unavailability** - If *Trivrit* rootbark (*Operculina turpethum*) is not available then *Mirabilis jalapa* is using in the market. The action of Mirabilis is quite strong more watery stools as well as gripping pain is there, sometime it is given with *Haritaki* too.

Image 17: *Trivrit* (*Operculina turpethum) and Mirabilis jalapa.*

- **Adulteration due to homonyms** - As there are various regional names available for various plants. *Aegle marmalos* L.- Rutaceae and *Commiferous caudata* L.- Burceraceae both are known as *bilva*. The adulteration can easily diagnose if the leaves are seen properly, The *Bilva* leaf is having serrate margin, specific characteristic odour as well as thickness of the leaf is more, while the Commiferous caudata leaves are glossy, slimy and papery in nature.

Image 18: *Bilva Aegle marmalos and Commiferous caudate.*

- **Similarity in colour** - *Kampillaka phala raja* (*Mallotus phillipinses*) admixture with powder of bricks are used.

Image 19: *Kampillaka phala raja* (*Mallotus phillipinses*) and Bricks Powder.

- **Adulteration for commercial purpose** - Saffron (*Crocus sativus*) is admixed with dried flowers of safflower (*Carthamus tinctorius* L.-Asteraceae).

Image 20: *Keshar* (*Crocus sativus*) and safflower (*Carthamus tinctorius*).

- **Debasement of inferior drug adulteration** - In *Ayurvedic* literature some drugs are mentioned to be taken as unripe, for example, *Balbilva* but for preparations if *Pakwa bilva* is taken this should be also considered as debasement with inferior substance.

Image 21: *Balbilva* and *Pakwa bilva.*

❖ **Evaluation methods of adulteration**

1. Morphological/Organoleptic Evaluation
2. Microscopic Evaluation
3. Physical Evaluation
4. Chemical Evaluation
5. Biological Evaluation
6. Chromatography and Spectroscpoic Techniques

1. **Morphological/Organoleptic Evaluation** - It includes characters like color, odor, taste, size, shape, special features like touch, texture etc. of crude drug.

- For example - Wavy shape-Rauwolfia, Disc shape-Nuxvomica, Conical shape- Aconite, Quills of cinnamon Brown color of cinnamon

Image 22: *Sarpagandha (Rauwolfia Serpentina)*.

Image 23: Disc shape *Kuchala (Strychnos Nuxvomica)*.

Image 24: Conical shape *Vastanabha (Aconitum ferox)*.

Image 25: Quills of *Twaka (Cinnamomnm zeylanicum)*.

2. **Microscopic Evaluation** - In this type of evaluation, drug or its powder are examined under the microscope to study the arrangement of tissue and characteristics of powder.

- For example - 1. Powder of clove stalk contain sclereids and calcium oxalate crystal but cloves (flower bud) does not contain these two.

  2. Sclerenchyma absent in *Rauwolfia Serpe*ntine root but present in *Rauwolfia micratha, R. densiflora species*

3. Physical Evaluation

Parameter	Description	Examples
Moisture content	The presence of excessive moisture content in drug will deteriorate its quality due to activation of enzymes which causes chemical changes or due to the growth of microorganism. It is **Karl Fischer method** or **Loss on drying method.**	*Guduchi* (fresh) – 75%[7] *Amalaki* - Not less than 80% [8]
Optical rotation	Certain substance has the property of rotating in plane of polarization in the pure state or in the solution. Dextrorotatory (+) and Levorotatory (-).	Clove oil 0° to 1.5°
Foreign organic matter	It is the part of plant present other than main drug part. Weight accurately 100gm of drug taken and spread in thin layer on paper. It is examined at 6X magnification and percentage recorded.	*Haridra* not more than 2 %[9] *Kunkuma* 2 %[10] *Shatavri* 1 %[11]
Volatile oil	Used to determine volatile oil content.	*Lavanga* (clove) not less than 15% *Dhanyaka* (coriander) not less than 0.3 % [12]
Melting point	It is useful parameter for determining the purity of solid, fixed oil and waxes.	Bees wax- 62-65° C Wool fat- 34-44° C Agar melts at 85°C
Refractive index	It is very useful for evaluation of volatile oil and fixed oil. It is physical constant that changes the speed of light. It is measured by Refractometer.	Castor oil (*Erand*) 1.4758 Clove oil 1.527-1.535
Solvent Extractive Value	This method determines the approximate amount of chemical constituents present in the given amount of medicinal plant material when extracted with solvent.	Aloe Not (*kumari*) less than 25% w/w[13] Glycyrrhiza (*Yashtimadhu*) Not less than 20% w/w[14]
	Water soluble extractive value It is used for drug containing water soluble active constituent of crude drugs such as tannin sugar, plant acid, mucilage, glycosides.	Aloe Not (*Kumari*) less than 10% w/w Glycyrrhiza (*Yashtimadhu*) Not less than 50% w/w
	Alcohol soluble extractive value Alcohol is ideal solvent for extraction of various chemicals like tannin, glycoside, resins etc. The solvent strength of alcohol varies from 20-95%.	
Ether soluble Extractive value	Volatile ether soluble extractives represent volatile oil content of drug.	Linseed (*Atasi*) Not less than 25 %w/w
	Nonvolatile ether soluble extractives represent resin, fixed oil or coloring matter present in drug	Capsicum (*Katuveera*) Not less than 12% w/w
Total Ash value	The amount of residue/ash left after the incineration is knows as ash value of the drug. The quality of drug also determined by the quantity left after ignition	*Guduchi* (Tinospora)-Not more than 16% *Amalaki*- 7%
Acid insoluble ash	Ash insoluble in dilute HCL. By this we can detect the presence of excessive earthy matter which is likely to occur with roots and rhizomes.	*Guduchi* (Tinospora) - Not more than 3% *Amalaki* – 2%
Water soluble Ash	It is used to detect the presence of material	*Shunthi* (Ginger)1.7% [15]

	exhausted by water 600°C	
Specific gravity	It is also known as relative density. The ratio of mass of a solid or liquid to the mass of an equal volume of distilled water.	Coconut oil (*Narikel*) 0.925 Castor oil (*Erand*) 0.95

4. Chemical Evaluation

Parameter	Description	Examples
Qualitative Chemical Test	Identification test for various Phytoconstituents like glycosides, alkaloids, tannin.	• Copper acetate test used to detect colophony as adulterant for resin, waxes and balsam • Van urk's test for ergot
Quantitative Chemical Test	This test included acid value, saponification value, ester value, acetyl value.	• Ester value of balsam & volatile oil, • Acid value for volatile oil, resin and Balsam
Chemical assay	Assay of alkaloids, resin, volatile oil, glycosides, vitamin or other constituent present in drug.	• *Ashwagandha* not less than 0.2 % [16] • *Kiratatikta* not less than 1.3 %
Chromatography & Instrumental analysis	Used to analyse the Phytoconstituents using chromatographic and spectroscopic method	• Thin Layer Chromatography • High-performance Thin Layer Chromatography • Gas Chromatography • Infrared spectroscopy

5. Biological Evaluation

When physical and chemical method are not able to produce satisfactory result then the drugs are evaluated by biological method of evaluation. This method of evaluation is also known as bioassay or biological assay in which plant extract are evaluated by various biological method to determine pharmacological activity. These assays are conducted by determining the amount of drug of known quantity required to produce a definite effect on suitable test. These methods are performed on living animal, isolating living organ and tissue and microorganism When the living bacteria, yeast and molds are used for assaying vitamin and to determine the activity of antibiotics drugs then it is called microbiological assay.

6. Chromatographic and Spectroscopic Techniques

Different types of chromatographic techniques are available for separation and analysis of component present in the drug and also to check the purity and quality of drug by using different types of spectroscopic techniques. In the spectroscopic techniques measurement and interpretation of electromagnetic radiation absorbed or emitted when the molecules or atom

or ion of a molecule of sample move one energy state to other. These methods are used for qualitative and quantitative evaluation of drugs.

Examples - TLC, HPTLC, HPLC, GLC, UV-Visible spectroscopy, IR Mass NMR

❖ DISCUSSION

Drugs	Identification	Adulteration	Evaluation
1. Hingu Image 26 *Ferula narthex, F. foetida* • *Niryas*	Surface of Niryas is smooth, dull opaque or vitreous, ranging from light brown to chocolate in color. Has got strong aromatic odour.	**Admixture** Inclusion of soil and stone pieces in *Hingu.*	1. Hingu+H_2o = white, yellowish milky stream 2. *Hingu* + Alkali = greenish yellow 3. *Hingu*+Sulphuric acid=Red (heat) 4. *Hingu*+Nitric acid = Green 5. Burn small quantity of asafoetida in a stainless-steel spoon. Pure asafoetida will burn like camphor. Adulterated asafoetida will not produce bright flame like camphor[17]
2. *Karpoor* Image 27 *Cinnamomum camphora* • *Niryas*	Camphor is colorless, crystalline solid granular mass. It has penetrating characteristic odor and aromatic pungent taste followed by sensation of cold.	**Admixture** Wax, resin, crystal, starch, gum and white, clean colored resinous substances are mixed in camphor	1. *Chini Karpoor* - floats over water. When kept open in the air, it flies and when burnt, it ignites quickly and a bright, smoky flame comes out. 2. *Bhimseni Karpoor* - sinks in water[18]
3. *Ella* Image 28 *Elettaria cardamomum* • *Beeja*	Fruits are three sided trilocular capsule, ovoid or oblong in shape with rounded base and slightly pointed beak. Seeds many, reddish brown in color, closely packed in each of 3 cells.	**Inferiority** and **Admixture** The fruits of *Maisuri, Malabari* cardamom is well known. Among these wild Elettaria cardamom var major are also sold in the markets under the name of *Ella.* Extracted fruits are mixed in *Ella*. It also contains a mixture of unripe, worm- eaten and cracked cardamom.	Fruits of this species are longer than pure *Ella* and their peel is of dark grayish brown color. Its seeds have only four wrinkles in the vertical direction, whereas the pure seeds have six to eight wrinkles in the horizontal direction. [19]
4. *Jatiphala* Image 29 *Myristica fragrans* • *Beeja*	Kernels are ovoid, surface is light brown in color, showing a network of shallow, reticulate grooves and marked with numerous small dark brown lines.	**Spoilage** and **Artifically manufactured** *Myristica malabarica,*	1.The fruits of wild nutmeg (malabarica) are longer (30-50 mm), less wide and somewhat soft as compared to real nutmeg. It does not even smell like real nutmeg.

		Myristica argentea Nutmeg is prepared by powdering old worm- eaten and rotten real nutmeg and mixing it in moist soil. Nutmegs have been similarly imitated by cutting bass-wood pieces to the required shape.	2.Wild nutmeg of *Myristica argentea* is also longer and wider than real nutmeg. It is very bitter in taste and has little smell. [20]
5. *Lavanga* Image 30 *Syzygium aromaticum* • *Pushpakalika*	Flower bud is reddish brown in color. It has got slightly flattened stalk and head composed of four calyx teeth and globular portion in the center.	**Deterioration** and **Admixture** The flower stalks, developed buds, petals, fruits and broken stamens of cloves are mixed. Most of the cloves available in the market have exhausted and dry cloves mixed in them.	1. Oil extracted cloves or old cloves are brown in color with weak odor and have a bitter taste. Pure – Dark gray 2. By hammering a nail into the stalk of a good clove, oil comes out quickly. 3. Well-nourished cloves sink when put in boiled cold water, but oiled cloves float on top of water. [21]
6. *Twaka* Image31 *Cinnamomum zeylanicum* • *Twaka*	Outer surface is deep fawn or yellowish brown in color with shining wavy lines running longitudinally. Inner surface is dark brown with faint straight striations.	**Inferiority** It is adultered with Cassia bark.	1. Cinnamon bark is very thin and can be rolled around a pencil or pen. It also has a distinct smell. Cassia bark is very thick and stiff and cannot be rolled. 2. Cassia bark comprises of several layers in between the rough outer and inner most, smooth layers. 3. On close examination of the bark a clear distinction can be made. [22]
7. *Aguru* Image32 *Aquilaria agallocha* • *Kandsaar*	The wood infected by certain fungi, develops large and irregular patches of dark streaks charged with an oleoresin and become odoriferous.	**Sophistication** The agar powder which is available in the markets under the name of ‘adulterated powder agar’ contains small pieces of *tagar* and other aromatic woods mixed in powder form.	1.It is black or dark brown pieces that are heavy in weight. These pieces sink when put in water. 2.When powdered, fiber free powder is formed. 3. When chewed it appears sticky and soft. [23]
8. *Ahiphen* Image33 *Papaver somniferum* • *Phalaniryas*	There are cubic weight-shaped pieces of opium. These are hard, sometimes brittle, sometimes flexible. Their external color is dark	**Admixture** To increase the weight of opium, its leaves, poppy seed powder, starch, salt	1.The best opium starts melting when kept in sunlight. 2.When put on fire, it starts burning but does not turn into coal.

	brown with blackish tint. Its inner part is dark brown, shiny and smooth. It has a specific type of strong unpleasant smell. It is bitter in taste	etc. are adulterated with it.	3.During combustion, its flame comes out clean, there is no waste or smoke and after extinguishing it, a very strong and intoxicating smell comes out. [24]
9. *Guggul* Image34 *Commiphora mukul* • *Niryas*	*Kana guggul*- Its round grains are of bloody yellow colour and are softer than *Bhaisa guggul*. *Bhaisa guggul:* It is found in small and big lumps of greenish yellow colour. The lumps also contain leaves, bark, pieces of wood and soil. It is soft like wax but becomes brittle when pressed.	**Inferiority** and **Admixture** To increase weight in *Guggul* sand, pebbles, wood fiber, bark, leaves etc. are added. *Kundru* (*Shallaki Niryas*), *Babbul Niryas* is also adulterated. A species of *Guggul Cominphora roxburghii* grown in Madhya Pradesh, Bengal, and Assam is also similar to *Guggul*.	1. When added in hot water, it forms a milky solution. 2. When kept in fire, first it melts, then gives off dark white smoke and then gets burnt. 3. When put in a test tube and burnt, it burns giving white smoke. Blood colored oil collects in the form of a drop in a cold test tube. [25]
10. *Vidanga* Image35 *Embelia ribes* • *phala*	The fruit of the real *vidanga* is circular, similar to black pepper but smaller than 6mm diameter is greasy black dark red in colour. Its fruit covering is brittle. On removing the outer pericarp, 1-2 other pericarp are found, which are lighter in color than the outer pericarp. Inside the fruit there is a spotted (pictured) red seed covered with a thin covering.	**Inferiority** In the market, many similar fruits are sold mixed or independently instead of the real *vidanga*. These are chiefly dominated by the dried fruits of species Embelia robusta or Myrsine africana.	Take 5 cc ether in a test tube. Add 0.2 grams (3 grains) of *Vidanga* powder in it, stir well and filter. On adding 1-2 drops of dilute solution of ammonia to this filtered solution, a purple-blue precipitate forms, which is an indication of the real stain. [26]
11. *Yashtimadhu* Image36 *Glycyrrhiza glabra* • *Moola*	(a) The outer skin is dark red or brownish red and thin. (b) Inner part- fibers are predominantly yellow, with some starch part in the middle. (c) The mid rib part is yellow in color with low fiber composition.	**Inferiority** The stems and roots of various other species of Glycyrrhiza are mixed.	1. When soaked in sulfur (80 percent solution in water), the soaked part becomes yellow in color. 2. The best *mulhathi* is sweet in taste and there is usually very little bitter taste. 3. When good *mulhathi* is burnt, the amount of ash does not exceed 10%. [27]
12. *Kutaki* Image37 *Picrorhiza kurroa* • *Moola*	In the market 1-2 inches long, rough, circular, tubular, bent pieces are	**Inferiority** Along with *Kutaki* root, *Gentiana*	Real *Kutaki* and *Karu* "*Trayamana*" - Their external structure appears to be almost

	found. On its TS (a) 1 mm of greyish brown epidermis (b) Endodermis of dark brown color 2-4 mm. gross (c) Heartwood: White in which five lines of black color appear. (d) The central part of the pith appears dark black.	*Kurroo royal Karu "Traymana"* and *Helleborus niger* roots are also sold in adulteration in the market.	similar but TS shows difference between the two. In Gentiana Kuro the thickness resulting from the growth of the cell envelopes of the vessels Annular thick linear but in *Kutaki* this thickness is dotted. The medullary cells located in the middle of the root have dotted covering. But Gentian Kuras do not have covers. [28]
13. *Raktachandan* Image38 *Pterocarpus santalinus* • *Kandasaar*	Red sandalwood is available in the market in small, large, cylindrical, long round pieces with dark blood-colored black spots. Hard, fibrous and heavy in weight, they sink when put in water	**Inferiority** Pieces of other odorless blood black colored woods are added. At some places in Bengal, the wood essence of the stem branches of *Adenanthera Pavonina* is also used in place of sandalwood.	a) Red sandalwood is minimal soluble in water. b) When its powder is mixed with alcohol, a dark blood color is produced. The soluble part in alcohol is about 2%. c) When the powder is put in fire, a light aroma is produced. The ash does not exceed 2%.[29]
14. *Madhu* Image39	Real honey is *pittabh shwet* or *raktabha*, *sandra*, *picchil* and semi-translucent. When old honey freezes it becomes like sugar candy.	Real honey consists of primarily sugar syrup, Invert sugar-artificial glucose, fructose or adulterated with sugar in small quantities.	a) Examined through litmus paper – mild acidic b) To identify color adulteration – b) Aqu.sol. + Ammonium = No Change c) For adulteration of starch and sugar, heat pure honey with water in 1-10 ratio, cool it and after adding two drops of iodine solution, no blue-green color should appear. d) The relative gravity of pure honey should not be less than 1.35. e) Mix honey and water in equal quantity and put the mixture in a test tube. Thereafter, put equal portion of Fehling's liquid in a test tube and heat it on steam. There will be no color change in pure honey. [30]
	The following testing methods are also prevalent for real honey. A) Smear the cotton swab with honey and burn it with a stick. If the swab burns with a crackling sound, then understand that sugar syrup has been mixed in it. When it burns wordlessly, consider it as real honey. B) Place one or two drops of honey on blotting paper. If honey is mixed with sugar syrup, after some time a water-like spot will appear under the paper (where the drops of honey have been placed). Not visible in real honey. C) Put one or two drops of honey on a cotton cloth and stand the cloth straight. The honey drop will slowly descend and will not get on the clothes, that honey is real. D) If a drop of honey, after putting it in water, remains the same as it is, it is real and if its size becomes smaller or bigger, then consider it as fake.		

15. *Ghrit* Image40		Mainly vegetable ghee, starch is mixed in it.	1. Put 10 cc ghee in a test tube and heat the ghee and melt it add 8cc Hydrochloric acid, after pouring, add 5 drops of Furforol solution. There is no change in the color of real *ghee*. If vegetable *ghee* is adulterated with *ghee*, then pink or red color is produced. 2. Take half teaspoon ghee in a transparent glass bowl. Add 2-3 drops of Tincture of Iodine. Formation of blue color indicates the presence of mashed potatoes, sweet potatoes and other starches.[31]

Image 26: Original *Hingu* And Adultered *Hingu*.

Image 27: *Karpoor* (*Cinnamomum camphora).*

Image 28: Rodent faecal matter And Real *Ella*.

Image 29: Basswood And *Jatiphala (*Myristica fragrans).

Image 30: Exhausted Clove and (*Lavanga* Syzygium aromaticum).

Image 31: Cassia bark And Twaka (Cinnamomum zeylanicum).

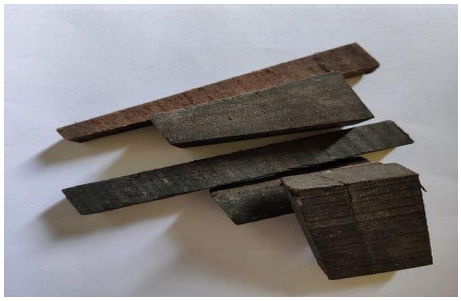

Image 32: Aguru (Aquilaria agallocha).

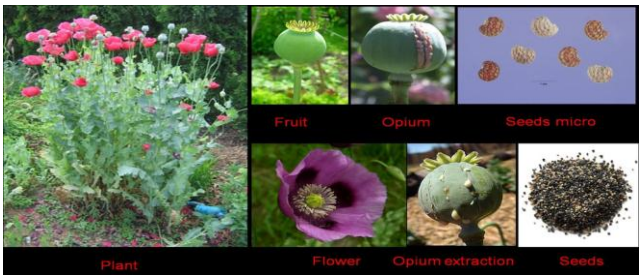

Image 33: *Ahiphena* (*Papaver somniferum*)

Image 34: ***Guggul (Commiphora mukul)*****.**

Image 35: ***Vidanga*** **(*Embelia ribes*).**

Image 36: ***Yashtimadhu (Glycyrrhiza glabra)*****.**

Image 37: ***Kutaki (Picrorhiza kurroa).***

Image 38: ***Raktachandan (Pterocarpus santalinus).***

Image: 39: *Madhu*

Pured Honey And Adultered Honey.

Image: 40 *Ghee*

Pured Ghee And Adultered *Ghee*.

❖ CONCLUSION

Counterfeiting and substitution are intertwined and create problems for the standardization of Ayurvedic practice and herbal medicine. The prospect can be intentional or accidental. To determine and detect adulteration, various stages of drug evaluation need to be carried out. Intentional adulteration must be stopped by enforcing strict rules. The main element for resolution is the correct authentication of the herbal medicinal plant sources mentioned in the classics. For this reason, it is necessary to conduct literature studies, ethnographic research, the study of medicinal plants, and evaluation of medicinal products (morphological, microscopic, chemical, physical, and biological assessments). After understanding adulteration methods, further research and information are needed to correct and minimize illegal adulteration to improve consumer safety. For this purpose, a review of scientific literature, journals, expert opinion, kinetics/dynamics, pharmacology interactions, side effects, toxicology, and dosage, etc., could be a great help. To provide safe and effective healthcare, it is necessary to ensure the quality of medicines.

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