

Lack of Pharmacological Basis of Substitution of an Endangered Plant Group “Ashtawarga”- A Significant Ingredient of Polyherbal Formulations

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ABSTRACT

Objective: Ashtawarga plants have been included among 560 plants appearing in the red list of endangered species. To overcome problem of scarcity of endangered species Department of AYUSH, Govt. of India has permitted the substitution of rare herbal drugs with available substitutes on the basis of Ayurvedic concepts. Metadata analysis has been carried out to find out the basis of substitution of the original Ashtawarga plants by similar plants.

Methods: The review on substitution of Ashtawarga plants was initiated by accumulating and analyzing the data presented on internet search engines, WHO and ancient Ayurveda texts Bhavaprakasha Nighantu, Sushruta Samhita and Charaka Samhita etc. In this review, *Rasa, Guna, Virya Vipaka, Doshic (Rasapanchakas)* and pharmacological actions of original Ashtawarga drugs and substitutes have been evaluated.

Result: The investigation of review indicates that only forty percent of total parameters of *Rasapanchakas* and pharmacological actions of Ashtawarga plants and their substitutes are similar whereas 60% of total parameters do not match with each other.

Conclusion: Our survey reflects that basis of substitution of individual herbs is neither based on pharmacological actions nor based on Ayurvedic philosophy of drug action. It seems that substitution of Ashtawarga plants is on the basis of some *Guna-Karma* similarities which are not clinically effective. As the *Rasapanchakas* are inter-related to each other, so any change in *Guna-Karma* property shall alter the therapeutic action of the drug. This basis of substitution has been found irrational and seems to play with the eternity and medical importance of Ayurveda at International level.

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INTRODUCTION

Humankind has always been attracted towards plants since time immemorial as source of food, shelter and medicine. Medicinal plants are the major basis of Ayurvedic and allopathic medicine. In India a major part of rural population depends on traditional medicine system like Ayurveda, Unani, Siddha and Homeopathy. Although after a publication of data indicating high levels of heavy metals in certain Ayurvedic preparations in JAMA in 2004 and 2008, the Ayurvedic drugs faced a setback yet their usage is gaining popularity among the common people due to long proven safety and natural origin^{1,2}. Ayurvedic preparations generally constitute a mixture of herbs where the availability of some ingredients is difficult and uneconomical. However to bring the product to a competitive lower price the manufacturers make substitution/adulteration with other freely available cheaper plant species. This substitution is playing with the drug standards, credibility and sanctity of Ayurvedic system as well as medicines³.

Moreover, there is a steep decline in human expertise capable of recognizing the various medicinal plants. The earliest sages recommended that the authentic plants were identified with the help of hermits, shepherds and tribal. During the olden days physicians themselves used to collect the herbs, prepare and administer the medicine whereas majority of modern Ayurvedic physicians are dependent on preformed Ayurvedic drugs in the market without knowledge of the constituents of herbal preparations. As a result, professional plant collectors have taken over the floor and the industry is forced to accept the herbs they bring on their terms without

question. These suppliers incapable to meet the increasing demand opt for adulteration with other plants. Literature analysis has been carried out to find out the Ayurvedic and pharmacological basis of substitution of the original Ashtawarga plants by other plants.

Ayurvedic concept of therapeutic /pharmacological action

Dravya (drug)

Dravya is defined as a substance which possesses properties (*Guna*) and actions (*karma*) together with an inherent relation. It is the place for the activities of *Rasa*, *Guna*, *Virya*, *Vipaka* and *Karma* (Badhanta Nagarjuna). Charaka stated that a drug is like a fabric material and its properties and action are like the yarn of the fabric. As per Ayurveda, physiological and biochemical effects of drugs and their mechanism of action in the body can be illustrated by pharmacodynamic principles namely *Panchamahabhutas* (penta-elements) i.e. *Rasa*, *Guna*, *Virya*, *Vipaka* and *Prabhava*, in terms of bodily components like *Tridosha* (*Vata*, *Pitta* and *Kapha*), *sapta dhatu* (different tissues), *mala* (morbid factors including urine, feces etc.), *srotas* (channels both macro vessels and micro vessels) and *agni* (enzymes & hormones)⁴.

Rasa

Rasa is the unique intelligence of the tongue or taste buds (*Rasana* or *Rasanendriya*) or is something experienced by an individual while consuming a drug. It is the instant taste on the tongue and the instant occurrence of how that particular taste influences the body. As per

modern physiology, taste is the direct action of a drug on the nerve endings in the mucous membrane of the mouth. Ayurveda classifies *Rasa* into six types and attributes its make up to five elements that comprise the ether, air, fire, water & earth. Short-term effect of *Rasa* has a direct influence on *Vata*, *Pitta* and *Kapha*. (Table.1) *Rasa* plays an important role in restoring the balance of the *Doshas*⁵.

Guna

Charaka defined *Guna* as the physical property which will remain in a drug with inherent relationship. Drugs may have 41 *Gun*as and act either by *Guna Prabhava* (influence of attributes) or *Dravya Prabhava* (inexplicable nature of drug) or both. Each drug is linked with some *Gun*as. Acharya Sushruta declared that *Gun*as can be detected through their action⁶. *Gun*as are susceptible to changes when undergoes to unusual *Samskaras* (rite of passage or processing) which obviously imitate the concept of *Nipata* (ingestion/ application), *Vipaka* (metabolism) and *Virya* (concentration of the drug in tissues) till its excretion from the body⁷. Certain *Gun*as on contact with tongue are subjected to initial digestion and exert certain actions that are attributed to *Rasa*. *Gun*as when further subjected to digestion and metabolism induce certain activities by virtue of their concentration in different bodily structures. In final stage, the drug molecules are synthesized which commence important actions that produced by release of effective *Gun*as named as *Virya* which can be attributed to *Vipaka* thus modifying principle of drug activity⁸.

Virya

Virya is considered as the most potent quality of a drug/active principle or a factor which is responsible for drug action/pharmacological action⁹. Each taste

has an energetic effect on digestion, creating either a heating or a cooling sensation known as *Virya* that refers to potency felt immediately or some time later after tasting a drug. *Virya* is classified into *Sheeta* (cold and decreases secretions and digestion, stabilizes excretion, stops bleeding, promotes vigour and vitality) and *Ushna* (hot and helps in storage of internal energy, increase digestion and thirst¹⁰. (Table.1)

Vipaka

Vipaka is defined as the last stage of transformation of drug after digestion/ metabolism through the action of *Jataragni* (digestive enzymes)¹¹. Taste has effect on metabolism after digestion is complete which lasts long and all the nutrients have been incorporated in the tissues. This effect is known as *Vipaka* which refers to the state of biotransformation of ingested drugs which occurs in dhatu / tissues and initiates biochemical reaction (oxidative & non-oxidative) that helps in generation of molecule and different actions¹. It is directly related to *Rasa*. When the effect of *Rasa* is immediate, local, physiological and psychological and quite perceivable then *Vipaka* action is delayed, systemic, physiological and inferable but not-perceivable. *Vipaka* is of three types i.e. *Madhura* (sweet -deeply nutritive and building), *Amla* (sour enhances digestive fire) and *Katu* (pungent increases elimination). Effect of *Vipaka* on *Tridosha* is depicted in Table 1^{5,9,10}.

Prabhava

The peculiar action of a drug is known as *Prabhava* and is characterized by specific actions of substances that cannot be explained in terms of the pharmacological actions of various constituents of drug considered individually in relation to each other. Chakrapani considered *Prabhava* as unpredictable and its effect is not

comparable to the effects expected generally from the constituents of a drug.¹³

Inter-relationship of *Rasapanchakas*

Acharya Sushruta primarily suggested that *Rasa*, *Virya*, *Vipaka* and drug are mutually dependent. Hence, drug is considered as the most vital and others (*Rasa*, *Virya*, and *Vipaka*) are dependent on it. According to *Sushruta*, *Virya* stimulates *Vipaka* which is based on *Guna* (like *Guru* and *Laghu*) but Charaka preferred *Rasa* oriented *Vipaka* theory and stated that *Rasa* is responsible for formation of *Virya*. Charaka and Sushruta have mentioned that each *Rasa* consists of three *Gunas* (*Madhura Rasa* possessing *Snigdha*, *Sheeta* and *guru Gunas*). Charaka and Sushruta also declared that the *Gunas* cannot act as base for another *Guna* but *Gunas* attributed to *Rasa*. This shows that all these attributes are inter-related (Table 1) and decides, complement, supplement or antagonize action of each other.

Ashtawarga plants

Ashtawarga plants (Ashta means eight and Warga means group) are a group of eight plants i.e. Kakoli, Kshirakakoli, Jeevaka, Rishbhaka, Meda, Mahameda, Riddhi and Vriddhi being widely used as a vital ingredient of many Ayurvedic formulations¹⁴. One of most widely used OTC product is chyawanprash which is acknowledged to revitalize the body of Rishi Chayawan and restored his youth.. These plants have health promoting and immense cell regeneration properties which work as antioxidants in the body and strengthen the immune system¹¹. Ashtawarga plants are also reported to restore health instantly and their requirement is rising day-by-day but accessibility of genuine drug is not in tune with the demand¹³.

Five hundred sixty plants in total of India have been included in the International

union for conservation of nature and natural resources (Red List of Threatened species) in which 247 species are in the threatened category which requires conservation strategies for protection¹⁸ and today Ashtawarga plants also come under this category due to limited distribution in their natural habitats. Because of endangered condition, today substitutes of Ashtawarga plants (Table 2, 3 & 4) are commonly used in Ayurvedic formulations to meet the market pressure, and the demand of cultivation of Ashtawarga plants is also declined because the deficiency of these plants is filled by their substitutes and this situation directly leads to substitution and adulteration¹⁹.

Concept of *Pratinidhi* drugs (substitute) as per official books

Some drugs which are available in the insufficient quantity within local area were rationally replaced by other drugs to get similar therapeutic properties in the absence of original drug known as *Pratinidhi* drugs and used in pharmacy practice because of easy availability and relatively low cost. Substitutes can be legal (official) that is scientifically proved (the drug has the similar properties to the original one) whereas illegal (commercial) means the drug has been used instead of the original drug and is not scientifically proved but otherwise is commercially beneficial to the adulterator or drug dealer²⁰.

The concept of substitute has been given by Bhavmishra (16th Century A.D.). It is clear that number of substituted plants in Ayurveda has been increased e.g. > 60 *Pratinidhi* drugs in *Bhavaprakasha*, > 70 in *Yogaratanakara*, about 75 in *Bhaishajya Ratnavali* and > 110 *Pratinidhi* drugs are mentioned in *Ayurveda Sarasamgraha* while, actual concept of *Pratinidhi* drugs was ignored¹⁸. According to Pharmacy, the concept of substitution is usually preferred

when original drugs are not available or available in small quantity²⁰. As per Pharmacognosy, the substitution refers to a part of adulteration which may be deliberate or accidental and this includes substitution of original crude drug partially or fully with other substances which is either free from or inferior in chemical and therapeutic properties²¹. Ayurveda recommended that the functionally similar substitute having similar *Guna-Karma* properties can be used in the absence of original medicinal herb and also states that *Rasa* (taste) of an herb depends upon its pharmacological action (*Karma*)²². Yogaratnakara stated that if *Rasa, Virya, Vipaka* of one drug is similar to another, then it may be selected as a substitute²³. The foremost Acharyas like Charaka and Sushruta have not given direct reference or listing of substitute while Charaka has emphasized on the *Prashasta Bhesaja* (ideal drug) which have following aspects for therapeutic use like *Bahuta* (readily available & in abundance), *Yogyatva* (eligible for therapeutic uses), *Anekvidha Kalpana* (capacity to be formulated in varied type) and *Sampat* (potential).

Acharya Vagbhata have declared that in the non-availability of any particular drug, one should try to get another similarly potent drug having similar *Rasa* (Taste), *Guna* (Quality), *Virya* (Potency) and *Vipaka*^{24,25,26}. Acharya Bhavamishra has stated that if original drug is not available then another drug which is similar to it in *Rasapanchakas* may be selected by the physician and used as substitute. Bhaishajya Ratnavali has declared that the main drug in any formulation cannot be substituted but only the accessory drugs in the formulation can be substituted by appropriate *Pratinidhi* drugs²⁰. However, World Health Organization has recommended the rejection of raw material, having more than 5% of any other plant part of the same plant (e.g. stem

in case of leafy drug), even though they are derived from the authentic plant. Based on these standards, adulterated drug (whether, intentional or unintentional) should be rejected²⁷. As per GMP rules & act in schedules-T for Ayurvedic, Siddha and Unani (ASU) drugs in the section 33EEA, ASU drugs are deemed to be spurious if it is substitute for another drug or if it has been substituted by other drug²⁸.

Reasons for the use of *Pratinidhi* drugs

Lack of knowledge of the authentic source

In Ayurvedic textbooks, many plants were not described and these plants were identified on the basis of characters like morphology e.g. Shatavari (Root of *Asparagus racemosus*) is used in place of Meda and Mahameda. One more illustration is Vidari kand that is being second-hand to Jeevaka and Rishbhaka and its botanical source is *Pueraria tuberosa* although it has been substituted by another plant i.e. Kshiravidari (*Ipomoea digitata*) while market samples are collected from another endangered gymnosperm *Cycas circinalis* which is sold as Vidari kand because cultivars, suppliers and vendors are unqualified and they are not familiar with authentic source^{20,29}.

Confusion in Vernacular Names

In *Ayurveda*, *Habenaria intermedia* refer to Riddhi but as per available literature survey, *Habenaria intermedia* refers to Vriddhi. Another example is Kshirakakoli i.e. also known as Kshira and Kakoli in Hindi. As per Ayurvedic pharmacopoeia of India, *Fritillaria roylei* and *Lilium polyphyllum* are the botanical names of Kshirakakoli and Kakoli, respectively but research literature listed *Lilium polyphyllum* and *Roscoea purpurea* as Kshirakakoli and Kakoli, respectively. Due to the similar or

controversial names, the herbs are often interchanged or adulterated^{30,31,32}.

Regional substitute

Under one name, a variety of drugs is used in different regions due to incorrect identification e.g. Jeevaka is known as Jeevakamu in Telugu but Jeevakamu is also used as common name in Telugu for another eight plants i.e. Riddhi, Elavalukam, Himsara, Khubkalan, Medasaka, Rumimastagi, Tailaparnah and Vanda³¹.

Non-availability of authentic plant

In case of non-availability of Kakoli (rhizomes) and Kshirakakoli (bulbs), Ashwagandha (root) is used as substitute³³.

Other part of same or different plant

Easy or bulk availability of other parts of same or different plant may lead to substitution e.g. tuberous root of *Lilium polyphyllum* is approved by API but rhizomes of this plant are widely used today for preparation of formulations^{15,32}.

METHODS

The review on substitution of Ashtawarga plants was done by accumulating and analyzing the data available on internet, WHO and ancient Ayurveda texts (Bhavaprakasha Nighantu, Sushruta Samhita and Charaka Samhita) etc. In this study, *Rasa, Guna, Virya, Vipaka, Doshic* and pharmacological actions of original Ashtawarga plants and their substitutes have been analyzed for their similarity that is basis of substitution as per ancient and modern texts.

RESULT

The analysis of data indicates that only forty percent of total parameters of *Rasapanchakas* and pharmacological actions of Ashtawarga plants and their substitutes

are similar whereas 60% of total parameters do not match with each other. *Rasapanchakas* are inter-related to each other so when one of *Guna- Karma* property changes then therapeutic action of the drug also changes. This shows that there is no scientific basis of substitution.

DISCUSSION

From the metadata analysis performed by authors following inferences can be drawn:

I. Single Ashtawarga plant but more than two substitutes

One Ashtawarga plant has 2 or 3 substitutes but *Rasa, Guna, Virya, Vipaka* and *Doshic* actions of substitutes are dissimilar from each other. How and on what basis 2 or 3 plants are selected as substitute for single Ashtawarga plant is not clear?

The basic Ayurvedic characteristics (*Rasa, Guna, Virya, Vipaka* etc) that decide the pharmacological action of any drug do not match with each other. For example, Riddhi has been substituted by varahi kand, Bala and Chiriya musli (Table 3). Even though the fact that Riddhi, Bala and Chiriya musli have *Madhura rasa* but Varahi kand have *Madhura, Katu* and *Tikta Rasas*. Ayurveda recognized that *Madhura Rasa* pacifies *Pitta* and *Vata* but aggravates *Kapha*. *Katu Rasa* decreases *Kapha*, increases *Vata* and *Pitta*. *Tikta Rasa* increases *Vata*, decreases *Pitta* and *Kapha*. Riddhi, Bala and Chiriya musli have *Guru* and *Snigdha Gunas* but Varahi kand have *Laghu Guna*. *Virya* of Riddhi, Bala and Chiriya musli is *Sheeta* but of Varahi kand is *Ushna*. Riddhi, Bala and Chiriya musli have *Madhura Vipaka* while Varahi kand have *Katu Vipaka*. *Doshic* action of Riddhi is *Tridosahar Pittahar*, Varahi kand have *Kapha-Vatahar Pittakar* doshic action but Bala and Chiriya musli pacify *Vata-Pitta*.

Pharmacological actions of Riddhi, Bala, Chiriya musli and Varahi kand are also not super-imposable. Varahi kand is totally different from Riddhi in the aspects of *Rasa*, *Guna*, *Virya*, *Vipaka*, *Doshic* and pharmacological actions. Similarly, Bala and Chiriya musli do not have similar *Doshic* and pharmacological actions (Table 3). So, how Bala, Chiriya musli and Varahi kand are regarded as substitutes for Riddhi?

II. Pairs of Ashtawarga plants have single official substitute

Ashtawarga plants are divided into four pairs and their similarities in Ayurvedic and pharmacological parameters are given in table (Table 5). Gunas and pharmacological actions of these pairs do not match with each other. Pairs of Ashtawarga plants are only different in one attribute of *Rasapanchakas* i.e. *Guna* but pharmacological actions of the drugs is of paramount importance for the selection of substitute. As selection criteria of *Pratinidhi* drugs clearly states that not only overall *Rasapanchakas* similarities are to be considered but also therapeutic efficacy. Both the drugs for each pair have different pharmacological profile but substitute of each pair is single plant (Table 5) which is officially accepted i.e. Ashwagandha for Kakoli & Kshirakakoli; Vidari kand for Jeevaka & Rishbhaka; Shatavari for Meda & Mahameda; Varahi kand for Riddhi and Vriddhi, which perhaps conserve two valuable plants. The selection of single plant as substitute for two plants having different pharmacological profile and different *Guna* property seems to be controversial. Another question that immediately floats is that if one plant can substitute two different plants then there was no basis of choosing these pairs for therapeutic action? If there was any relevance in the selection of these pairs in ancient times, then there must be a scientific basis for that selection and substitution of

that pair by single plant drug seems to be irrational and unscientific.

III. Ashtawarga pair have single official substitute but different other substitutes

Another important observation that came out of this metadata analysis is substitution of substitutes. Pair of Ashtawarga plants have single official substitute but other substitutes, which have been used in the absence of official substitute, are different by their therapeutic and pharmacological actions e.g. in the absence of Ashwagandha, Kali musli and Safed musli are used as substitute of Ashwagandha. Ultimately, Kali musli and Safed musli are regarded as substitutes for Kakoli and Kshirakakoli, respectively. Kali musli and Safed musli are also different plants with different morphological and pharmacological profile then how both are accepted as substitute for single plant i.e. Ashwagandha. Kali musli is used as substitute for Kakoli and Safed musli for Kshirakakoli in the absence of Ashwagandha.

If Ashwagandha can be used as first substitute for both Kakoli and Kshirakakoli then why one type of musli cannot be used as substitute for both Kakoli and Kshirakakoli in place of Ashwagandha?

IV. Basis of substitution

Substitution on the basis of Ayurvedic principles

One important basis of the substitution could be the Ayurvedic principles like *Rasa*, *Guna*, *Virya*, *Vipaka* and *Doshic* action but this does not seem true (Table 2, 3, & 4) because more than 50% substitutes (*Pratinidhi* drugs) of Ashtawarga plants do not show similarities in *Rasa*, *Guna*, *Virya*, *Vipaka* and *Doshic* actions except with similarity of one or two attributes (Fig 1) e.g. *Vipaka* of Kakoli and

its substitutes is *Madhura* i.e. similar but *Rasa, Guna, Virya* and *Doshic* action of Kakoli and substitutes are not super-imposable. This indicates that Ayurvedic principles were not followed while selecting *Pratinidhi* drugs for Ashtawarga plants.

Substitution on the basis of modern pharmacology

The other most important criteria for substitution could be the pharmacological action and it seems that it was also not considered selecting substitute. Chemical constituents and pharmacological actions of the Ashtawarga plants and their substitutes are given in the tables (Table 2, 3 % 4) and similarities of pharmacological actions are shown in Fig 1. Chemical composition and pharmacological activities of Kshirakakoli are totally different from its substitutes i.e. Ashwagandha and Safed musli. Another example is Jeevaka which also possess different pharmacological profile from their substitutes (Guduchi, Vidari kand and Safed behman). This suggests that in case of Ashtawarga plants and the substitutes are not selected on the basis of modern pharmacological parameters.

Substitution on the basis of taxonomy

Among all *Pratinidhi* drugs of Ashtawarga plants, it is evident that different plant part used in 75% cases while only in 25% cases similar plant part used. Abhava *Pratinidhi* drugs are dissimilar taxonomically as they belong to different families or species. e.g. Vriddhi belongs to family Orchidaceae but its substitutes belongs to Dioscoreaceae and Malvaceae families (Table 3). This shows that there is no taxonomical basis behind this substitution.

CONCLUSION

Ayurvedic principles suggests that use of suitable locally available plant that are easy to obtain and in abundance on the basis of their *Guna-Karma* properties but substitution of Ashtawarga plants do not follow Ayurvedic principles exactly except some similarities in *Rasa, Guna, Virya, Vipaka* and *Doshic* action. This is an era of evidence based medicine and the most important criterion for selection of *Pratinidhi* drugs is pharmacological actions rather than similarities in Ayurvedic parameters. In case of Ashtawarga, pharmacological profile of Ashtawarga plants and their substitutes is totally different. From this study it may be concluded that substitution of Ashtawarga plants done by various agencies and by Department of AYUSH, Ministry of AYUSH, Govt. of India is neither based on pharmacological basis nor based on Ayurvedic principles and there is no scientific rational behind substitution. Due to this, quality of herbal products are finally effected which may cause great loss to consumers worldwide due to continuous use of herbal drugs without desired medicinal value. This may also create a bad impression towards efficacy and sanctity of Ashtawarga based Ayurvedic/traditional medicine and the system as a whole. Thus, it is prerequisite to compare the drugs with an entire aspect, which goes in hand by hand with a holistic approach of Ayurveda that is "Treat the man as whole - Take the drug as whole".

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Conflict of interest

No conflict of interest.

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Table-1: Inter-relationship of Panchamahabhutas (*Rasas, Gunas, Virya and Vipaka*) and their effect on *Tridosha*⁵⁷

Panchama habhutas	Sub-types of Panchamahabhutas and their effect on Tridosha																	
	Madhura (Sweet)			Lavana (Salty)			Amla (Sour)			Katu (Pungent)			Tikta (Bitter)			Kashaya (Astringent)		
Aggravates	Kapha			Kapha, Pitta			Kapha, Pitta			Vata, Pitta			Vata			Vata		
Alleviates	Vata, Pitta			Vata			Vata			Kapha			Kapha, Pitta			Kapha, Pitta		
Guna	Sheeta	Guru	Snigdha	Ushna	Laghu	Snigdha	Ushna	Laghu	Snigdha	Ushna	Laghu	Ruksha	Sheeta	Guru	Ruksha	Sheeta	Guru	Ruksha
Aggravates	Vata, Kapha	Kapha	Pitta, Kapha	Pitta	Vata, Pitta	Pitta, Kapha	Pitta	Vata, Pitta	Pitta, Kapha	Pitta	Vata, Pitta	Vata	Vata, Kapha	Kapha	Vata	Vata, Kapha	Kapha	Vata
Alleviates	Pitta	Vata, Pitta	Vata	Vata, Kapha	Kapha	Vata	Vata, Kapha	Kapha	Vata	Vata, Kap ha	Kapha	Pitta, Kapha	Pitta	Vata, Pitta	Pitta, Kap ha	Pitta	Vata, Pitta	Pitta, Kapha

Table- 2: Description of Ashtawarga plants (Kakoli, Kshirakakoli, Meda and Rishbhaka) and their substitutes

Description	Ashtawarga plants	Substitutes of Ashtawarga plants	
Common name	Kakoli	Ashwagandha	Kali musli
Other names	Kakoli (Hindi)	Asgandh (Hindi)	Musli safed (Punjabi)
Name as per Ayurveda &/or API	Kakoli	Asvagandha	Talamuli
Botanical name	<i>Lilium polyphyllum</i> D. Don	<i>Withania somnifera</i> Dunal.	<i>Curculigo orchioides</i> Gaertn.
Family	Liliaceae	Solanaceae	Amaryllidaceae
Chemical constituents	Sugars, flavonoids, alkaloid, saponins, glycosides, tannins, phenolic compounds ^{11,27}	Alkaloids and withanolides ³⁰	Tannin, resin, saponin and alkaloid ²⁹
Pharmacological action	Antirheumatic, immunostimulant, diuretic, aphrodisiac, antipyretic, anabolic, febrifuge, galactogauge,	Antirheumatic, immunostimulant, diuretic, aphrodisiac, antioxidant, anabolic, antiinflammatory,	Immunostimulant, diuretic, aphrodisiac, antioxidant, anabolic, antiinflammatory, hepatoprotective, hypoglycemic, anticancer,

	sweet, bitter haemostatic, refrigerant, expectorant, tonic, cooling ^{11,33}	hepatoprotective, hypoglycemic, anticancer, psychotropic, adaptogenic, antistress, anticonvulsant, narcotic, antibiotic, hypnotic, antibacterial, antifungal, macrophage activator, tonic galactagogue, alterative ^{33,38-41,52}	spasmolytic, demulcent, antipyretic, antidiarrhoeal, analgesic restorative, spermatogenic, antiasthmatic, antihistaminic, tonic ^{42-48,56}
Part used	Tuberous root	Roots	Rhizome
Rasa	Madhura	Tikta, Kashaya	Madhura, Tikta
Guna	Sheeta, Guru	Laghu	Guru, Picchila
Virya	Sheeta	Ushna	Ushna
Vipaka	Madhura	Madhura	Madhura
Doshic action	Pitta-Vatahar Kaphakar	Vata Pitta pacifying	Vata Pitta pacifying – Kapha aggravating
Common name	Kshirakakoli	Ashwagandha	Safed musli
Other names	Kshira, Kakoli (Hindi)	Asgandh (Hindi)	Mushli (Sanskrit)
Name as per Ayurveda &/or API	Ksirakakoli	Asvagandha	Not mentioned in API
Botanical name	<i>Fritillaria roylei</i> Hook.	<i>Withania somnifera</i> Dunal.	<i>Chlorophytum horivilianum</i> Sant & F.
Family	Liliaceae	Solanaceae	Liliaceae
Chemical constituents	Alkaloids, terpene alcohols, steroidal glycosides ^{26,11}	Alkaloids, withanolides, amino acids, steroids, Steroidal Lactones, volatile oil, starch, reducing sugars, glycosides, alkane, sugar alcohol, withaniol, an acid and a neutral compound ^{30,60}	alkaloids, carbohydrates, vitamins, proteins, steroids, saponins, sugars, mineral, phenol, resins, mucilage ⁹
Part used	Bulb	Roots	Roots
Rasa	Madhura	Tikta, Kashaya	Madhura, Tikta
Guna	Guru, Snigdha	Laghu	Snigdha, Picchila, Guru
Virya	Sheeta	Ushna	Ushna
Vipaka	Madhura	Madhura	Madhura
Doshic action	Vata Pitta pacifying	Vata Pitta pacifying	-----
Pharmacological action	Antirheumatic, diuretic, aphrodisiac, antitubercular, antiasthmatic, expectorant,	Antirheumatic, immunostimulant, diuretic, aphrodisiac, antioxidant, anabolic, antiinflammatory,	Antiarthritic, immunomodulator, diuretic, aphrodisiac, antioxidant, hypoglycaemic, antitumour, adaptogenic, antistress,

	antipyretic, oxytocic, tonic, sweet, bitter, refrigerant, hyperdipsia, haematemesis, rheumatagia, galactogauge, useful in disorders like general debility, agalactia, cough, bronchitis, vitiated conditions of pitta, burning sensation, seminal weakness, strangury ^{50,51}	hepatoprotective, hypoglycemic, anticancer, Psychotropic, adaptogenic, antistress, anticonvulsant, narcotic, antibiotic, hypnotic, sedative, antibacterial, antifungal, macrophage activator, galactogogue, alterative, tonic ^{33,38-41,52}	antimicrobial, larvicidal, antiulcer, anthelmintic, anxiolytic, analgesic ^{53,54}
Common name	Rishbhaka	Vidari kand	Lal behman
Other names	-----	Vidareekand (Hindi)	-----
Name as per Ayurveda &/or API	Not mentioned in API	Vidarikanda	Not mentioned in API
Botanical name	<i>Microstylis muscifera</i> (Lindl.) Ridl.	<i>Pueraria tuberosa</i> DC.	<i>Centaurium roxburghii</i> (D. Don) Druce.
Family	Orchidaceae	Fabaceae	Gentianaceae
Chemical constituents	Bitter alkaloids, glycoside, flavonoids with active derivate compounds.	Pterocarpan, pterocarpanone, pterocarpenes, isoflavones, coumestan ²⁶	Alkaloids ⁶⁸
Part used	Psuedobulb	Tuber	-----
Rasa	<i>Madhura</i>	<i>Madhura</i>	-----
Guna	<i>Guru, Snigdha</i>	<i>Guru, Snigdha</i>	-----
Virya	<i>Sheeta</i>	<i>Sheeta</i>	-----
Vipaka	<i>Madhura</i>	<i>Madhura</i>	-----
Doshic action	<i>Vata Pitta</i> pacifying	<i>Vata Pitta</i> pacifying	-----
Pharmacological action	Aphrodisiac, antidiarrhoeal, antidysentric, antipyretic, sterility, vitiated conditions of vatta and pitta, seminal weakness, tonic, styptic, cooling, internal and external haemorrhage, in dysentery, febrifuge, emaciation,	Anti-inflammatory, antispasmodic, hepatoprotective, antioxidant, cardioprotective, antihyperglycemic, hypolipidemic, anti-ageing, for the treatment of fertility disorders & general weakness ⁶¹⁻⁶⁵	Bitter tonic, useful in the loss of appetite and peptic discomfort ⁶⁸

	haemostatic, burning sensation, general debility, sweet, refrigerant ^{11,59}		
Common name	Meda	Shatavari	Salam mishri
Other names		Satavar, Satamul (Hindi)	-----
Name as per Ayurveda &/or API	Not mentioned in API	Satavari	-----
Botanical name	<i>Polygonatum verticillatum</i> (Linn.) Allioni	<i>Asparagus racemosus</i> Willd.	<i>Eulophia campestris</i> Wall.
Family	Liliaceae	Liliaceae	Orchidaceae
Chemical constituents	Amino acid, sterol, steroid saponin, sugar	Sugar, Glycosides, Saponin and sterol.	-----
Part used	Rhizomes	Tuberous roots	-----
Rasa	<i>Madhura</i>	<i>Madhura, Tikta</i>	-----
Guna	<i>Guru</i>	<i>Guru, Snigdha</i>	-----
Virya	<i>Sheeta</i>	<i>Sheeta</i>	-----
Vipaka	<i>Madhura</i>	<i>Madhura</i>	-----
Doshic action	<i>Vata Pitta</i> pacifying	<i>Vata Pitta</i> pacifying	-----
Pharmacological action	Aphrodisiac, diuretic, analgesic, pyrexia, in burning sensation, phthisis and weakness, tonic, galactogauge, emollient and appetizer ¹¹	Antitumour, immunomodulator and galactogauge, antidiarrhoeal, anti-inflammatory, useful in disorders like nervous disorders, dyspepsia, dysentery, hyperdipsia, neuropathy, hepatopathy, cough, bronchitis, hyperacidity, certain infectious diseases ^{66,67}	Antioxidant, appetizer, anthelmintic, aphrodisaic, stomachic, tonic, cough, cardioonic, discrasia ⁷³

Table- 3: Description of Ashtawarga plants (Jeevaka, Vriddhi, Riddhi) and their substitutes

Common name	Jeevaka	Vidari kand	Safed behman	Giloe
Other names	Jeevak (English, Hindi)	Vidareekand (Hindi)		Guduchi (Official name)
Name as per Ayurveda &/or API	Jivakah	Vidarikanda	Not mentioned in API	Guduci
Botanical name	<i>Malaxis acuminata</i> D. Don. syn. <i>Microstylis wallichii</i> Lindl.	<i>Pueraria tuberosa</i> DC.	<i>Centaurea behen</i> Linn.	<i>Tinospora cordifolia</i> (Willd.) Miers.
Family	Orchidaceae	Fabaceae	Compositae	Menispermaceae
Chemical constituents	Alcohol, sugars, diterpenes, alkaloid, glycoside, flavonoids, O-methylbatatasin, 1, 8-cineole, sterol, coline, monoterpene, phenylpropanoid, cyclic terpene, monoterpene ^{26,34,35,58}	Pterocarpan, pterocarpanone, pterocarpenes, isoflavones, coumestan ²⁶	Saponins, steroids and alkaloids ¹¹	Terpenoids and alkaloids ³⁰
Part used	Psuedobulb	Tuber	Roots	Stem
Rasa	<i>Madhura</i>	<i>Madhura</i>	-----	<i>Tikta, Kashaya</i>
Guna	<i>Picchila, Snigdha</i>	<i>Guru, Snigdha</i>	-----	<i>Laghu</i>
Virya	<i>Sheeta</i>	<i>Sheeta</i>	-----	<i>Ushna</i>
Vipaka	<i>Madhura</i>	<i>Madhura</i>	-----	<i>Madhura</i>
Doshic action	<i>Vata Pitta</i> pacifying	<i>Vata Pitta</i> pacifying	-----	<i>Tridoshic</i>
Pharmacological action	Antirheumatic, anti-inflammatory, aphrodisiac, analgesic, antitubercular, useful in disorders like bleeding diathesis, burning sensation, phthisis, haematesis, fever, seminal, dipsia, weakness, burning sensation, emaciation, general debility	Antirheumatic, antiinflammatory, aphrodisiac, antioxidant, antispasmodic, antitubercular hepatoprotective, diuretic, cardioprotective, laxative, contraceptive sweet, refrigerant, emollient, galactogogue, emetic, expectorant, febrifuge, used for the treatment of hepatosplenomegaly, leprosy, dyspepsia, spermatorrhoea &	Antiinflammatory, aphrodisiac, antioxidant, hepatoprotective, cardio tonic, antianxiety, exhilarant, effective in improving memory, relieves sexual debility, thickens seminal fluid ⁵⁵	Antiinflammatory, hepatoprotective, diuretic, antiulcerogenic, anticancer, antistress, immunomodulator, hypoglycemic, antiallergic, antimicrobial, expectorant

		cough		
Common name	Riddhi	Varahi kand	Bala	Chiriy musli
Other names	-----	Varahi kanda (Hindi), Varahikanda (Sanskrit)	-----	-----
Name as per Ayurveda &/or API	Riddhi	Varahi	Not mentioned in API	Not mentioned in API
Botanical name	<i>Habenaria intermedia</i> D. Don	<i>Dioscorea bulbifera</i> Linn.	<i>Sida cordifolia</i> Linn.	<i>Asparagus filicinus</i>
Family	Orchidaceae	Dioscoreaceae	Malvaceae	Asparagaceae
Chemical constituents	Starch, minerals with bitter substances and phenolic compounds	Steroidal saponins and Saponins, spiroconazole A, phenanthrene, 2,7-dihydroxy-4-methoxyphenanthrene, flavonoids as quercetin, quercetin-3-O-β-D-glucopyranoside, and quercetin-3-O-β-D-galactopyranoside, and seven clerodane diterpenoids namely, bafoudiosbulbins A, B, C, D, E, F, and G ²⁹	Alkaloid, amino acid, amine derivative, Ephedrine, pseudoephedrine, sterculic, betaphenethylamine, saponine, hypaphorine, ecdysterone, indole alkaloids, palmitic, stearic and β – sitosterol, malvalic and coronaric acid, fatty acids ⁷⁴	Saponins, steroidal saponins, shatavarins, immunoside, sarsapogenin, glycosides of quercetin, rutin, hyperoside and diosgenin, quercetin 3-glucuronide, sitosterol, stigmasterol along with their glucosides, spirostanolic and furostanolic saponins, sapogenin, polycyclic alkaloid, asparagamine, disaccharide ⁷⁵
Part used	Tuber	Rhizome	-----	Tubers
Rasa	Madhura	Madhura, Katu, Tikta	Madhura	Madhura
Guna	Guru, Picchila, Snigdha	Laghu	Guru, Snigdha, Picchila	Guru, Snigdha
Virya	Sheeta	Ushna	Sheeta	Sheeta
Vipaka	Madhura	Katu	Madhura	Madhura

Doshic action	<i>Tridosahar Piitahar</i>	<i>Vata Pitta</i> pacifying	<i>Vata Pitta</i> pacifying	<i>Vata Pitta</i> pacifying
Pharmacological action	Cooling, brain tonic, emollient, blood purifier, appetizer, rasayan, tonic, asthma, gout, leprosy, skin diseases, worms anorexia, general debility, fever, burning sensation, excessive thirst, cough, emaciation ¹¹	Analgesic, antidiabetic, cardiotoxic, cytotoxic, antiinflammatory, gastroprotective, cytotoxic, diuretic, anthelmintic, antibacterial, useful for the treatment of leprosy, sore throat, struma ⁷²	Analgesic, CNS depressant, antiinflammatory, hypotensive, hepatoprotective, Anti microbial, antiparkinson, antimicrobial, hypoglycemic, adaptogenic, antioxidant, hypotensive, antiasthma ⁷⁴	Antitumour, hypoglycemic, immunomodulator, antiviral, galactogauge, antioxidant, antiabortifacient, spasmodic to uterus, antioxytoxic, hypertensive, anticoagulant, antidysenteric ⁷⁵
Common name	Vridधि	Varahi kand	Salam panja	Maha bala
Other names	-----	Varahi kanda (Hindi), Varahikanda (Sanskrit)	-----	Pitabala (Hindi), Khurunti (Punjabi)
Name as per Ayurveda &/or API	Not mentioned in API	Varahi	Not mentioned in API	Mahabala
Botanical name	<i>Habenaria edgeworthii</i> Hook. f. ex Collet	<i>Dioscorea bulbifera</i> Linn.	<i>Dactylorhiza hatagirea</i> (D. Don) Soo	<i>Sida rhombifolia</i> Linn.
Family	Orchidaceae	Dioscoreaceae	Orchidaceae	Malvaceae
Chemical constituents	Starch, minerals with bitter substances & taxol	Steroidal saponins and Saponins, spiroconazole A, phenanthrene, 2,7-dihydroxy-4-methoxyphenanthrene, flavonoids as quercetin, quercetin-3-O-β-D-glucopyranoside, and quercetin-3-O-β-D-galactopyranoside, and seven clerodane diterpenoids namely, bafoudiosbulbins A, B, C, D, E, F, and G ²⁹	Dactylorhins A to E, dactyloses A and B, lipids glucoside, starch, mucilage, albumen, volatile oil, ash and bitter substance ⁶⁹	Alkaloids ²⁷
Part used	Tubers	Rhizome	Tubers	Roots

Rasa	<i>Madhura</i>	<i>Madhura, Katu, Tikta</i>	-----	<i>Madhura</i>
Guna	<i>Guru, Snigdha</i>	<i>Laghu</i>	-----	<i>Guru, Snigdha, Picchila</i>
Virya	<i>Sheeta</i>	<i>Ushna</i>	-----	<i>Sheeta</i>
Vipaka	<i>Madhura</i>	<i>Katu</i>	-----	<i>Madhura</i>
Doshic action	<i>Tridosahar Piitahar</i>	<i>Vata Pitta pacifying</i>	-----	-----
Pharmacological action	Cooling, emollient, brain tonic, blood purifier, gout appetizer, rasayan, tonic, in asthma, leprosy, skin diseases, anorexia, worms, general debility, burning sensation, excessive thirst, fever, cough, emaciation, spermopiotic ¹¹	Analgesic, antidiabetic, cardiotoxic, cytotoxic, antiinflammatory, gastroprotective, cytotoxic, diuretic, anthelmintic, antibacterial, useful for the treatment of leprosy, sore throat, struma ⁷²	Antibacterial, aphrodisiac, antidiarrhoeal, In the treatment of dysentery, chronic fever, cough, stomachache, wounds, cuts, burns, fractures, general weakness ⁶⁹	-----

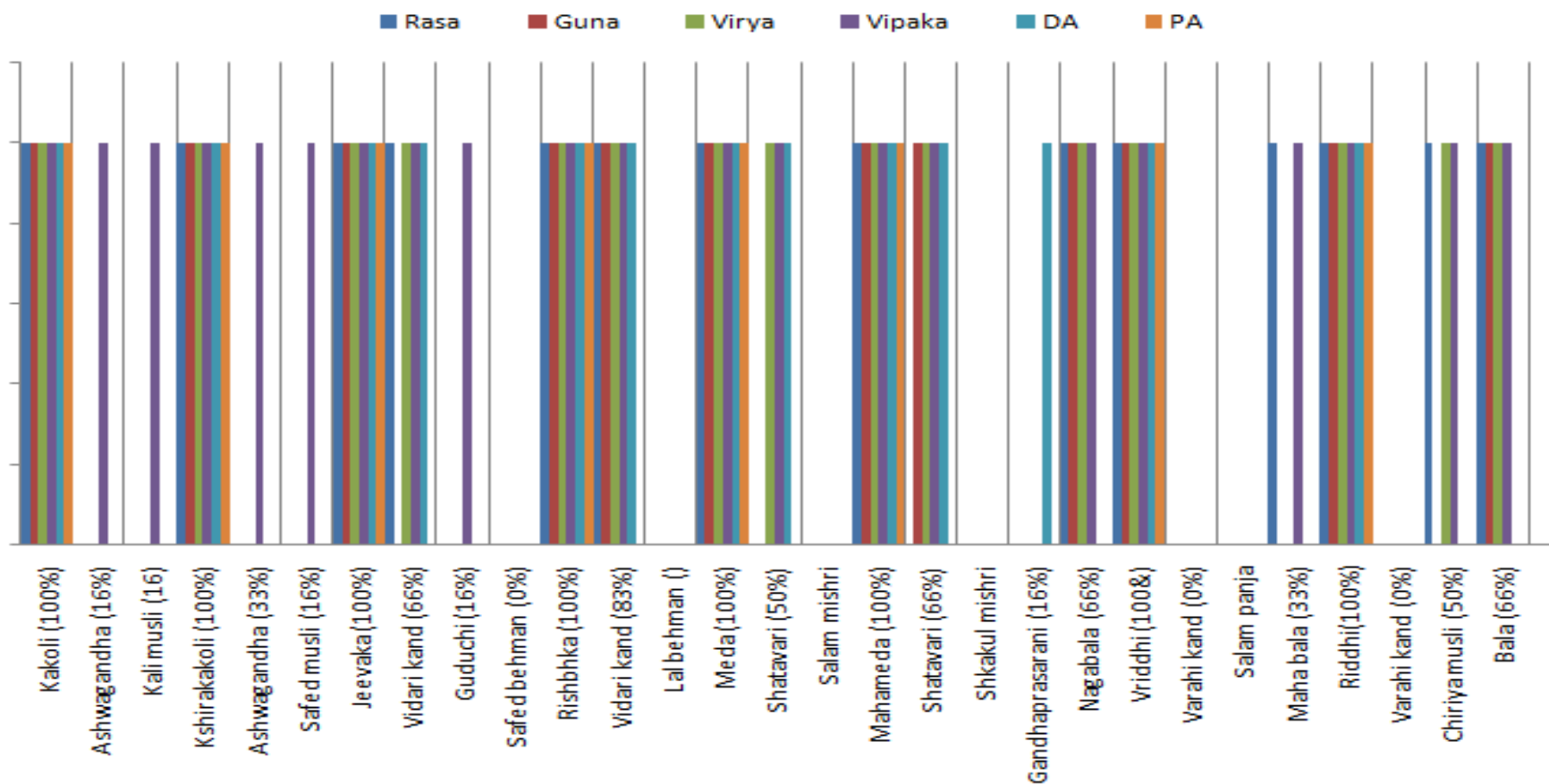
Table- 4: Description of Ashtawarga plant (Mahameda) and their substitutes

Common name	Mahameda	Shatavari	Prasarani	Nagabala	Shakukul mishri
Other names	Mahameda	Satavar, Satamul (Hindi)	Gandha Prasarini (Hindi)		Black haired Mr. He
Name as per Ayurveda &/or	Mahameda	Satavari	Prasarini	Not mentioned in API	Not mentioned in API

API					
Botanical name	<i>Polygonatum cirrhifolium</i> (Wall.) Royle	<i>Asparagus racemosus</i> Willd.	<i>Paederia foetida</i> Linn.	<i>Sida himilis</i> Car syn. <i>Sida veronicaeolia</i> Lam.	<i>Polygonatum multiflorum</i> (Linn.) All.
Family	Liliaceae	Liliaceae	Rubiaceae	Malvaceae	Polygonaceae
Chemical constituents	sugar (API), steroidal saponins	Sugar, Glycosides, Saponin and sterol.	Alkaloids, volatile Oil, asperuloside, paederosidic acid, phenolic compounds, sitosterols, stigmaterol, campesterol, ellagic acid, lignans, iridoids, methylenedioxy compound, tannins, triterpenoids, urosilic acid, epifriedelinol ⁷⁰	Alkaloids, phytosterols, carbohydrates, flavanoids, fatty acids, aminoacids, hydrocarbons, alcohol, coumarins, phenolic acids	-----
Part used	Rhizomes and root	Tuberous roots	Whole plant	-----	-----
Rasa	<i>Madhura</i>	<i>Madhura, Tikta</i>	<i>Tikta</i>	<i>Madhhura</i>	-----
Guna	<i>Guru, Snigdha</i>	<i>Guru, Snigdha</i>	<i>Guru, Sara</i>	<i>Guru, Snigdha</i>	-----
Virya	<i>Sheeta</i>	<i>Sheeta</i>	<i>Ushna</i>	<i>Sheeta</i>	-----
Vipaka	<i>Madhura</i>	<i>Madhura</i>	<i>Katu</i>	<i>Madhura</i>	-----
Doshic action	<i>Vata Pitta</i> pacifying	<i>Vata Pitta</i> pacifying	<i>Vata Pitta</i> pacifying	-----	-----
Pharmacological action	Cooling, mild laxative, galactogauge, aphrodisiac, depurative, wound healer, febrifuge, expectorant, tonic and fungicidal ¹¹	Antitumour, immunomodulator and galactogauge, antidiarrhoeal, anti-inflammatory, useful in disorders like nervous disorders, dyspepsia, dysentery, hyperdipsia, neuropathy, hepatopathy, cough, bronchitis, hyperacidity, certain infectious diseases ^{66,67}	Anti-inflammatory, antiarthritic, antioxidant, antirhematic, antihyperglycemic, antimicrobial, cytotoxic, antinociceptive, antiulcer, antiulcer, antidiarrhoeal, antihyperglycemic, antitussive, anthelmintic, hepatoprotective, in the treatment of colitis ⁷⁰	-----	Antiaging, antiapoptotic, antineurotoxicity, antihepatic cancer, cholestasis, breast cancer, hair growth, antioxidant, Alzheimer's disease, Parkinson's disease and vascular dementia ⁷¹

Table- 5: Pair of Ashtawarga plants and their similarities in *Ayurvedic* and pharmacological parameters

Sr. No.	Pairs of Ashtawarga plants	Similarity in						Single official substitute for two different drugs	Different substitutes for single drug
		<i>Rasa</i>	<i>Guna</i>	<i>Virya</i>	<i>Vipaka</i>	<i>Doshic action</i>	Pharmacological action		
1.	Kakoli and Kshirakakoli	√	×	√	√		×	Ashwagandha	Kali musli & Safed musli
2.	Jeevaka and Rishbhaka	√	×	√	√	√	×	Vidari kand	Safed behman & Lal behman
3.	Meda and	√	×	√	√	√	×	Shatavari	Salam mishri &



Ashtawarga plants and their substitutes

Fig. 1: % Similarities of Ashtawarga plants with their substitutes