SUMMARY AND CONCLUSION
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Plants are vital for the existence of life on the universe. The major source supply of drugs used for the treatment of human ailments is plants and plant products. Medicinal plants are the local heritage with global importance and the world is endowed with a rich wealth of medicinal plants. Plant based medicines have been one of the important source of health care system since the beginning of human civilization. Inspite of tremendous developments in the field of allopathy during 20th century, plants still continue as one of the major sources of drugs in modern as well as traditional medicine throughout the world. India has one of the oldest, richest and most diverse cultural traditions associated with the use of medicinal plants, which ranked our country in the list of top producers of herbal medicines. Plant based products have been in use for medicinal, therapeutic or other purposes right from the dawn of history. Traditionally, plants have been used extensively in human, vetenary and even plant health care. Kerala with its rich biodiversity has contributed a great extent to the development of Ayurveda, the most popular Indian traditional health care system.

The present study is the result of a much felt need to identify the genuine source plant, its suitable substitutes and to identify the adulterants. The origin of the problem is unscrupulous adulteration and substitution with spurious drugs due to the non-availability of the genuine plants/ parts in sufficient quantities. The vast
destruction of forests, destructive harvesting of plant parts like root, heart wood, bark etc have led to the extinction of many precious species and decline of the resource base of others. The non availability of genuine drug lead to wide variation in quality and therapeutic efficacy of Ayurvedic medicine. This condition will badly affect the ayurvedic health care system in the above contest it has become a necessity to find out quality control parameters to find out the genuine raw drugs mentioned in the classical texts and the possible substitutes. In this contest the present study envisages to explore the possibility of finding out the correct identity of three controversial drugs which includes seven plants, most widely used controversial drugs, through comparative pharmacognostic and phytochemical studies. Special emphasis have been given to microscopic, histochemical and chemical finger printing of raw drugs and their substitutes using modern analytical techniques like HPLC, HPTLC & GCMS. This study has wide implication such as clearly identifying the genuine material as the substitute that can be used in the place of genuine drug. The results helps to:

1. Find out a solution and to give an answer to the correct substitute which is being used in practice.

2. Develop quality standard of 3 raw drugs and their substitutes/adulterants obtained in Kerala markets and to check the adulterants.
The identification of the genuine, approved substitute helps to a greater extent to wipe out the practice of adulteration and lead to a standard for the identification of selected raw drugs and the finished product out of it. Now it is compulsory that all the ayurvedic industry must check the genuineness of the raw drugs before manufacturing. To check the identity of the raw drug and to stop the use of unauthorized substitutes and adulterants. This quality standards will be useful. In the absence of genuine herbs, evolving quality standards of the authentic substitute is very important. This ensures the quality and efficacy of the medicine. The present study aims at evolving markers for the correct identification of the genuine herb and the most suitable substitutes and applying this method for the floor level checking of the raw drugs used in medicine manufacture. 

*Plumbago indica* and *Plumbago zeylanica* are used as source plants of the drug *citraka*. Anatomically roots of *Plumbago indica* and *Plumbago zeylanica* show variations in certain characters. Cortex and medullary rays containing few starch grains, broader nature of medullary rays and absence of mechanical elements in the phloem are the features that differentiate *P. indica* from *P. zeylanica*. Large number of starch grains are found in the cortex and medullary rays. Narrow Medullary ray and presence of phloem fibers are the characteristic features of *P. zeylanica*. Length of xylem vessel is large in *P. zeylanica*, width and wall thickness are more in *P. indica* compared to *P. zeylanica*. Deposition of pumbagin is more in *P.*
*indica* than in *P. zeylanica*. From the chemical comparison, TLC profiles of the ethanolic extracts were taken and *Rf* values of the prominent bands of *P. indica* and *P. zeylanica* were compared and the TLC profiles of the two plants were almost similar. Quantification of plumbagin was carried out using the area under the curve method. The concentration of plumbagin shows difference in *P. indica* and in *P. zeylanica*. The quantity of plumbagin is more in *P. indica* than *P. zeylanica* and this result is proportionate to the histochemical localization of plumbagin shown in the section of *P. indica* and *P. zeylanica*. *P. indica* is having more plumbagin and is used after purification process. In North India *P. zeylanica*, is used without purification process. Hence it is highly essential to find out the identity of species in dried form, which is available in the market for commerce. The aforementioned methods are the best tools to identify the species. The major reported compounds present in *P. indica* were plumbagin, plumbagic acid lactone, 2, 3-epoxyplumbagin, plumbagic acid, 3-O-3’-bidorserone and zeylanone. Plumbagin, 3-chloroplumbagin, zeylinone, isozeeylinone are the reported compounds present in *P. zeylanica*.

The above studies revealed that these two plants show similarities in morphological, anatomical and phytochemical levels. Both these plants are used in ayurveda as *citraka*. *P. indica* is used after purification and *P. zeylanica* without purification. The reason of purification is to remove the excess plumbagin which is neurotoxic in
nature. The plumbagin at low doses gives stimulant action on nerves but at high doses it causes irritation to skin and is highly toxic, which leads to paralysis and ultimately death. Hence it is necessary to select species with low plumbagin content. According to the present study, *P. indica* contains higher quantity of plumbagin than *P. zeylanica* and during purification process using lime water, excess of plumbagin oozes out into the lime water. Due to the high demand of this raw drug, both these species may be used as *citraka*.

From the Kerala market survey it is found that about 100% of the drug *Citraka* are found to be *P. indica*, which is the drug source of *Citraka* in Kerala. From the study it is concluded that the commonly available *P. zeylanica* can also be used as genuine *Citraka* without purification.

*Holostemma ada-kodien* and *Leptadenia reticulata* are the source plants of the drug *jivanti*. Anatomically roots of *H.a ada-kodien* and *L. reticulata* show variations and similarities in certain characters. In *H.a ada-kodien* groups of stone cells are arranged in the form of a broken ring, diameter of the xylem core is short, druse crystals of calcium oxalates are present in the cortical region, but in the case of *L. reticulata* a narrow broken ring of stone cells are present. Wood region forms the major part of the root in *L. reticulata* compared to *H. ada-kodien* and in *L. reticulata* prismatic crystals of calcium oxalates are present in the cortical region and medullary ray cells. Large number of starch grains are present in *H. ada-kodien* when
compared to *L. reticulata*. Length, width and wall thickness of vessels and fibres are large in *L. reticulata* when compared to *H. ada-kodien*. In *H. ada-kodien* and *L. reticulata* the TLC profiles and Rf values of the prominent bands were determined and the TLC profiles of the two plants were almost similar. Quantification of β-sitosterol was carried out using the area under the curve method. The concentrations of β-sitosterol shows differences, the concentration of β-sitosterol in *H. ada-kodien* is 0.735% and in *L. reticulata* is 0.018%. Fructosan (7-8 hexose unit) of inulin type, aliphatic esters stigmasterol ∞ and β amyrin, β-sitosterol and flavonoids-diosmetin and luteolin are the other compounds present in *L. reticulata*. The study reveals that *H. ada-kodien* have high therapeutic activity than *L. reticulata* and have common activity with that of *L. reticulata*. This shows some positive sign towards the substitution possibility of *H. ada-kodien*.

The study reveals that market samples show differences according to the place of collection. The sample collected from one district is an adulterant and the anatomy is different from the genuine sample. From the Kerala market survey it is calculated that about 90% of the raw drug *Jivanti* was found to be *H. ada-kodien*, the raw drug sources of *Jivanti* used in Kerala and 10% were found to be adulterant.

In the case of *rasna* three plants are being used. *Alpinia galanga* and *Alpinia calcarata* are used in Kerala and in Northern side *Pluchea*
lanceolata. In the rhizomes of A. galanga the vascular bundles are large and the number of vessel members is much more but in A. calcarata the vascular bundles are considerably small in size and the vessel members are also fewer in number. Absence of starch grains in the stele as well as the difference in the shape of the starch grains are the features that differentiate A. galanga from A. calcarata. In P. lanceolata vascular bundles are arranged in the form of a ring and calcium oxalate crystals are present. In A. galanga, A. calcarata and P. lanceolata the TLC profiles and Rf values of the prominent bands were determined and the TLC profiles of the three plants were almost similar. α-pinene, β-pinene, limonene, terpinen-4-ol, a-terpineol, linalool, methyl eugenol, eugenol, and 1,8-cineole are the compounds present in A. galanga. In A. calcarata the major compounds are methyl cinnamate, cineol and camphor. β and γ sitosterol, and Pleuchein are the major compounds present in P. lanceolata. GC analysis of the three plants shows differences due to difference in the nature of the compounds present in these three plants.

Anatomical and chemical comparison of the market samples of rasna show differences in amount of cell inclusions according to the place of collection. In Kerala under the drug Rasna two drugs are available ie, Aratta (A. galanga) and Chittaratta (A. calcarata). From anatomical and phytochemical analysis, which were carried out for the market samples, it was revealed that in Kerala market about 90%
of the materials were *P. lanceolata* which is available under the name *Aratta* and *Alpinia calcarata* is available under the name *Chittaratta* and 10% was found to be adulterant.

The quality standard developed from the study for the genuine and the accepted substitute for the selected raw drug would be useful in the identification of raw drugs which is available from the suppliers and serve, as a standard. Quantification of marker compounds present in each raw drug was done by HPLC/HPTLC methods, which can also be considered as an additional parameter for quality checking of these raw drugs. The data evolved can be considered for laying down the pharmacopoeial standards for the selected raw drugs. The data obtained are interpreted and discussed in the light of current classical literature.

The significance of the study are: (i) In the present scenario, the use of unauthorized substitutes and adulterants in the absence of genuine herbs, evolving quality standards of the authentic ones is very important as it helps in identifying the genuine drugs from their spurious adulterants. This ensures the quality of medicines. The present study produced an easy and effective method for the correct identification of the genuine herbs and substitutes used in medicine manufacture. (ii) Quality standard parameters of 3 ayurvedic drugs and their substitutes and adulterants were prepared. (iii) Market survey of 3 raw drugs from the 13 districts of Kerala was carried out and studied the authenticity of the raw drugs used for the medicine manufacture.
preparation. (iv) Pharmacognostic and phytochemical markers were standardized to check the genuineness of the raw drugs obtained from different sources. (v) Chemical constituents were identified and compared with market samples of genuine as well as approved substitutes and adulterants. (vi) Methods for TLC, GC, GCMS and HPLC of the 7 medicinal plants have been standardized.

Major contribution to the society from the current study are (i) it is mandatory that all the Ayurvedic industry must check the genuineness of the raw drugs before manufacturing the drugs and adulteration is a clear instance of violation of Drugs & cosmetic Act. To check the identity of genuine raw drug and to stop the use of unauthorized substitutes and adulterants in the absence of genuine herbs. (ii) The identified chemical marker can be used for the floor level quality checking of the authenticity of raw drug used for the medicine preparation. (iii) The study gives information on the possible substitutes having similar properties of three important drugs. (iv) To sort out the confusion in the identity of the genuine source plants from their other source plants.

The identification of the genuine and approved substitute will help to a great extent to wipe out the practice of adulteration and lead to a standard for the identification of raw drugs and finished products of Ayurveda.

Use of authentic raw drug will certainly help in providing good quality medicine to millions of people who depend on the traditional
herbal system of medicine and hence this study is a humble attempt with a great national importance. More over the outcome of the study can be used as a tool for quality control measures, which will be useful to herbal drug industry, practitioners of Indian system of medicines, academicians, researchers and other bonafide users.