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Review Article

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## HERBAL DRUG FORENSICS

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### Abstract:

Herbal drugs are the drugs which are obtained from natural resources. Today there is an exorbitant demand of herbal drugs in the market that promises to cure ailments naturally, but due to scarcity of medicinal plants, indiscriminate deforestation and illegal trade, there is an excessive gap between the availability of medicinal plants and drugs obtained from them which have paved the way for inundate adulteration in herbal drugs. *Asparagus racemosus* commonly called as Shatavari is indeed a highly rejuvenating herb for both male and female, a revitalizing tonic for most of the problems related to hormonal changes and reproductive system. Thus there is an elevated level of adulteration and substitution in the form of synthetic drugs (eg: sildenafil citrate), similar looking parts of the plant (Safed Musli), plants inducing similar properties to the herbal drugs, etc. Present case study underlines how herbal drug forensics can help in untangling the hidden harms in adulterated commercial *A. racemosus* root powder samples as compared to standard root powder and the need to develop this undermined area of forensic science towards a better future.

**Keywords:** Adulteration, *Asparagus racemosus*, Herbal drug forensics, Herbal drugs, Shatavari.

## INTRODUCTION:

A fundamental Ayurvedic philosophy is that *“food is medicine and medicine is food”*. According to an Ayurvedic proverb *“When diet is wrong, medicine is of no use; when diet is correct, medicine is of no need”*.

Food, the fundamental for the sustenance of life is not unblemished from various malfeasances owing to the adulteration and falsification of food commodity. Not only food but the drugs also are no safer enough to be completely relied upon. The food and the herbal drugs (prepared from the medicinal flora having one or more bioactive constituents) market offer a huge income due to growing population, their needs, consumerism and marketism. The various food products and herbal drugs available in the market are carrying lot of adulterants and counterfeits that are almost impossible for a common man to detect [1, 2, 3, 4, 5, 6]. **Herbal drugs forensics** is a branch of forensics and a multidisciplinary science that not only answers the questions as to “what” and “how much” related to drug safety and quality issues but also investigates the sources, fate, implications and possibilities related to adulteration, falsification, counterfeiting and substitution in nutraceuticals (the drugs or herbal supplements consumed for extra nutrient intake that is not fulfilled by routine diet) and herbal medicinal drugs.

***Asparagus racemosus*** ( Figure 1) commonly known as “Shatavari” is one of the plants having lot of health benefits and is a potential rejuvenator for both men and women and acts as a revitalizing tonic for most of the problems related to hormonal changes and reproductive system and is a commonly used nutraceutical. The dried root powder is consumed for the same purpose as the drug is herbal and causes no side-effects. Since the yield after drying fresh root tubers is very less, the plant is exploited on a large scale to obtain the drug which has lead to endangering of the wild species found in India. These days, the reproductive problems are very common in men and women due to changing lifestyle, environmental factors, climatic changes, workload, bad food and sleeping habits, etc., the requirement for such drug is ever increasing which creates a wide gap between the demand and supply in the market. This demand and supply gap have paved the way for inundate adulteration in such herbal drugs by addition of either look alike plant parts or exhausted drug or synthetic drugs which are

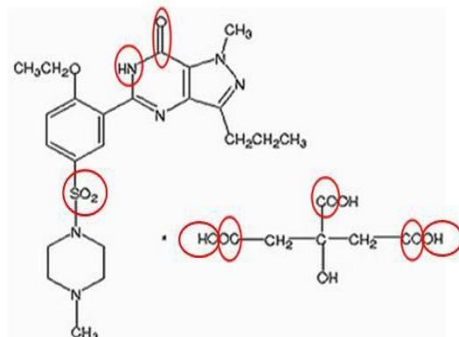
similar in activity as the plant's bioactive principle<sup>[7, 8, 9]</sup>. (For example: Belladonna leaves are substituted with Ailanthus leaves, dried flowers of *Carthamus tinctorius* commonly known as Safflowers are mixed with saffron, many herbal formulations are adulterated with antibiotics, synthetic steroidal drugs, and synthetic antioxidants, red chilli powder is adulterated with brick powder, wheat flour with chalk powder, turmeric with metanil yellow, and many more). *A. racemosus* contains natural steroidal saponins like "Shatavarin I, Shatavarin II, Shatavarin III, Shatavarin IV, etc., which are responsible for its usage in reproductive ailments. It acts as galactagogue <sup>[10, 11]</sup> (pharmaceutical and herbal compounds used to increase lactation) in females whereas it increases fertility and treats problem of impotency in males.



**Figure 1:** *Asparagus racemosus* tubers

The *A. racemosus* powder and other medicinal formulation of *A. racemosus* sold in the market possess a high risk of being adulterated with such synthetic steroids that act in similar way for the human reproductive system as does by steroidal saponins of shatavari. For example- Sildenafil citrate class of drugs commonly known as 'Viagra' is a synthetic formulation of 1-[4-ethoxy-3-(6, 7-dihydro-1-methyl-7-oxo-3-propyl-1H-pyrazolo [4,3d] pyrimidin-5-yl)phenylsulfonyl]-4-methylpiperazine citrate<sup>[12]</sup> (Figure 2) . The drug is commonly consumed by male patients having erectile dysfunction (ED) upon the prescription of a medical practitioner <sup>[13]</sup>. The recommended doses of this drug are 25mg or 50mg or, 100mg in severe cases but not more than that and also once in a day. The drug though is efficient in treatment of ED disorders but produces many side effects and adverse effects such as irregular heartbeat, shortness of breath, angina, myocardial infarction, stroke, sudden hearing loss, blindness, etc. <sup>[14]</sup>.

So, if the drug is being added by the manufacturer intentionally in medicinal and dietary supplements containing Shatavari and without any labelling, it is unethical and will put the health of consumer under serious threat. [14].



**Figure 2:** Sildenafil citrate structure

**Case report:** For that, we conducted a detailed study on standard *A. racemosus* root powder and few market samples of *A. racemosus* powder of popular ayurvedic brands. We processed the fresh root tubers collected from a nearby botanical garden in Gandhinagar, Gujarat, to form the powder and then we purchased ten different samples of *A. racemosus* powder from market and online stores. We started our analysis by preliminary physical examination like cost, colour, texture, odour, etc. i.e. the organoleptic properties and found huge difference between the standard and the market samples and among the different market samples itself. We preceded our study to chemical examination in which we tried to make a phytochemical profile (the list of chemical constituents present in the plant) of standard and market samples. Amino acids are the common and important constituent in this drug. We found one market sample that showed negative result for the presence of amino acids.

There we decided to go further in our analysis and then we moved to thin layer chromatographic (TLC) technique. At this point, we also purchased Sildenafil citrate and similar drugs commonly available at medical stores. Along with standard powder, we spotted the market drug samples and sildenafil citrate drug on TLC plate and found that the same drug that was negative in amino acid test was giving similar colour spot and same R<sub>f</sub> value (it is the ratio of distance moved by solute as compared to solvent; similar R<sub>f</sub> means that the standard and sample drug belong to same origin and difference in R<sub>f</sub> value indicates the non-compliance of sample drug with the standards) as that of sildenafil spot.

To get more surety on our results we further moved to instrumental techniques that are more reliable as compared to conventional techniques. First we tried with Fourier Transform Infrared Rays (FTIR) technique in which we found that the peak given by same doubtful market sample matched with the characteristic peak given by sildenafil citrate and other peaks were similar to that given by corn starch. At next, we did ion chromatographic (IC) determination of amino acids and carbohydrates. In amino acid analysis by ion chromatography, we found good results with standard powder but again the doubted market sample gave negative results for the presence of amino acids. Out of 22 standard amino acids tested, none were present in the doubtful market sample. In carbohydrate analysis by ion chromatography, we found that the doubtful sample was having highest concentration of carbohydrate, the same sample that showed similar peak to that of corn starch in FTIR analysis, while the standard shatavari did not show much concentration of carbohydrate.

**Conclusion:** From the whole analysis, we were able to conclude that one of the market samples was completely counterfeit as having starch as its bulk component which looks similar to powdered shatavari roots and adulterated with synthetic drug-sildenafil citrate that functions in a similar way as shatavari. Thus, the manufacturers produced the same structural and functional properties as Shatavari by two way adulteration.

*"We can't talk about our own health without understanding our place in our environment, because in order to fulfill our potential we have to live in the context of our surroundings. We have to know our place in the ecosystem of which we are a part, and this means living 'consciously': being aware of nature and how it affects us and how we, in turn, affect nature."*

A quote from Sebastian Pole's 'Discovering the True You with Ayurveda: How to Nourish, Rejuvenate, and Transform Your Life', very well explains the importance of awareness, be it our surrounding, our body or our food. Therefore, Herbal drug forensics is one of the most significant emerging fields of forensic science and from the above example it clearly demarcates the intervention of forensics into food and drug quality assessment.

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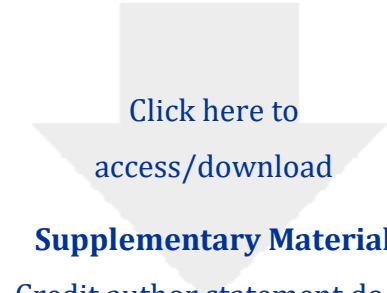
**Conflict of Interest:** The authors do not have any conflict of Interest.

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