

Review on Pharmacopoeial Standards of 'Asgand' (*Withania somnifera* (L.) Dunal)

¹*Nitin Rai

and

²Rajeev Kr. Sharma

¹Pharmacopoeial Laboratory
for Indian Medicine,
Kamla Nehru Nagar,
Ghaziabad-201002

²Pharmacopoeia Commission
for Indian Medicine,
Raj Nagar, Ghaziabad-201002

Abstract

The dried mature roots of *Withania somnifera* (L.) Dunal are specified source of drug named 'Asgand' or 'Ashwagandha'. The drug is highly regarded for varied therapeutic values in Unani, Ayurvedic, Siddha and Homoeopathic system of medicine. The drug has been compared to *Panax ginseng* for its endurance - enhancing properties. The drug enjoys the official status in Unani Pharmacopoeia of India, Ayurvedic Pharmacopoeia of India, Siddha Pharmacopoeia of India, Homoeopathic Pharmacopoeia of India and Indian Pharmacopoeia. Pharmacopoeial monographs are regulatory standards and mandatory for compliance to ensure the quality, safety and efficacy of drug. This communication reviews the pharmacopoeial monographs and analytical parameters specified in pharmacopoeial and non pharmacopoeial publications with a view on harmonization of quality specifications on *W. somnifera* of drug in pharmacopoeias.

Keywords: *Withania somnifera* (L.) Dunal, Pharmacopoeias, Pharmacopoeial harmonization.

Introduction

W. somnifera (L.) Dunal. (Family-Solanaceae) is specified botanical source of 'Asgand' or 'Ashwagandha' in various pharmacopoeias. The drug has been used in Unani system of medicine since a long time. It is an official drug and one of the ingredient of a number of important Unani classical and patent formulations. The Ashwagandha is also used in ayurvedic, siddha, homoeopathic and modern system of medicine. *W. somnifera* (L.) Dunal. is attributed medicinal as abortifacient, alexipharmica, alternative, aphrodisiac, astringent, deobstruent, diuretic, hypnotic and sedative, narcotic, pungent, restorative and tonic. It is medicinally used in carbuncles, cough, debility of old age, dropsy, emaciation of children, general weakness, promotes urination, functional obstruction of body, rheumatism, scrofula, senile decay, ulcers and vulnerary treatment. The drug finds mention in classical literature of unani, ayurvedic, siddha and homoeopathic system of medicine. The tender shoots of the plant are also used as a vegetable and seeds are used as masticatory. The green berries are bruised and rubbed on ringworm in human beings and on animal sores and girth-galls in horses. They are also employed to curdle milk. The drug is substituted with *W. coagulans* Dunal. (Kirtikar and Basu, 1933; Chopra *et al.*, 1956; Nadkarni, 1954; Anonymous, 1976).

¹*Author for correspondence

Systematics of source plant : *W. somnifera* (L.) Dunal belongs to family Solanaceae. Solanaceae Juss. Lindl. Veg. Kingd. 618, Endl. Gen. 662. Miers, Illustr. S. Amer. Pl. 1849-1857, Gen. Pl. II: 882.

This family comprises about 20 genera and 2,000 species found in tropical and temperate regions of the world with the prime centers in Central and South America. In India, this family is spread over 15 genera and 88 species, mostly in the Himalayas and the mountains of Southern India.

Genus: *Withania* Pauquy. Diss. de Bellad. Paris, 1824, ex Endl. Gen. 666; Gen. Pl. II: 893, FBI 4:239. The genus consists of ten species which are distributed in South America, South Africa, Canaries and Mediterranean to India. In India, 2 species are distributed in drier regions. The generic name of the plant is supposed to be in honour of H. Withan, a British geologist and writer on Paleontobotany, in the nineteenth century.

W. somnifera (L.) Dunal. In DC. Prodr. 13: 453. 1852; FBI 4:239; FUGP 2:128, *Physalis somnifera* Linn. Sp. Pl. 182. 1753, *P. flexuosa* Linn. Sp. Pl. 182. 1753. Synonyms: *Physalis flexuosa* Linn and *P. somnifera* Linn. An erect much branched, evergreen, perennial, undershrub with glutinous cells sap. Roots fairly long, stem very short, stellate hairy often with hoary mealy extremities. Leaves simple, short petioled, alternate, or in sub-opposite pairs at a node, exstipulate, elliptic-oblong or ovate rounded with an acute decurrent base. Flowers greenish or yellowish, small, sessile or short pedicellate, axillary fascicles or in crowded fascicles of two to five. Calyx gamosepalous, five or six lobed, campanulate, stellate-hairy, lobes ovate-triangular, acute, corolla small, gamopetalous, campanulate, three to six lobed to more than half way down, ovate, stellate, hairy outside. Stamens five, inserted on the tube of the corolla near its base, anthers broadly elliptic oblong and dehiscing longitudinally, pistil bicarpellary, many ovuled, syncarpous, ovary ovate-globose, style glabrous, linear filiform and stigma bifid. Fruit berry, globose, enclosed within the enlarged calyx, stellate hairy, seed very many and discoid. Flowering and Fruiting: January to September.

Distribution : The drug plant is distributed throughout the drier subtropical regions of India. In global distribution it is reported from Arabia, Mediterranean regions, Pakistan to Persia, the Canaries and to tropical and South Africa (Chopra *et al.*, 1958; Sharma and Kachroo, 1983).

Observations

The Pharmacopoeial monographs on herbal drugs published in Unani, Ayurveda, Siddha, Homeopathic and Indian Pharmacopoeias are dealt in detail for content review (Rai *et al.*, 2012, 2013 and Tiwari *et al.*, 2013). It was observed that

drugs 'Asgand' or 'Ashwagandha' (botanically specified as *W. somnifera* (L.) Dunal.) is subjected for regulatory standards in Unani Pharmacopoeia of India, Ayurvedic Pharmacopoeia of India, Siddha Pharmacopoeia of India, Homeopathic Pharmacopoeia of India, Indian Pharmacopoeia, British Pharmacopoeia and United State Pharmacopoeia (Table -1). Non regulatory quality standard are also published on the drugs in Indian Herbal Pharmacopoeia and Quality Standards of Indian Medicinal Plants. (Anonymous, 1940; 1955; 1966; 1971; 1976; 1986; 1996;1998; 2000a & b; 2002; 2007; 2008 a & b; 2010; 2011; 2013 a & b and 2014.) The monographs published in these pharmacopoeial and non-pharmacopoeial publications are reviewed as per the pharmacopoeial parameters to assess the variability in quality standards of drug. Table-2 exhibit the format of pharmacopoeial monographs in various edition of pharmacopoeias. Table-3 & 4 provide the account of pharmacopoeial standards on drug published in pharmacopoeias. Non- regulatory quality standard published in Indian Herbal Pharmacopoeia and Quality Standards of Indian Medicinal Plants are enumerated in Table-5.

Conclusion

India is the only country which recognizes the five pharmacopoeias of different systems of medicines under regulatory frame work (Anonymous, 1940). Indian

Table 1: Pharmacopoeial status of *Withania somnifera* (L.) Dunal.

Botanical Name (as specified in Pharmacopoeial Monograph)	Morphological Part specified as drug	Pharmacopoeial/ Monograph Title	Regulatory/ Pharmacopoeial References
<i>Withania somnifera</i> (L.) Dunal	Dried mature root	Ashwagandha	IP 2007 IP 2010 & IP 2014
		Ashwagandha dry extract	IP 2010 & IP 2014
		Amukkara	SPH
		Withania radix, Aswagandha	IP 55& IP 66
		Asvagandha	API- I & VIII
		Asgand	UPH
		Withania somnifera	HPI-I & VIII
		Withania Somnifera Root	British Pharmaco- poeia (BP) 2013
Asvagandha Root	The United States Pharmacopoeia (USP 36/NF 31) 2013		

Abbreviations: API-Ayurvedic Pharmacopoeia of India, UPI-Unani Pharmacopoeia of India, SPI-Siddha Pharmacopoeia of India, HPI-Homeopathic Pharmacopoeia of India, IP-Indian Pharmacopoeia, BP -British Pharmacopoeia, USP-United States Pharmacopoeia India.

Table 2: Monograph pattern in various edition of Indian Pharmacopoeia.

Sl. No.	Quality Specification	Unani Pharmacopoeia of India, Part-I (UPI) Volume-I	Ayurvedic Pharmacopoeia of India, Part-I (API) Volume-I & VIII	Siddha Pharmacopoeia of India, Part-I (SPI) Volume-I	Homoeopathy Pharmacopoeia of India (HPI) Volume-I & VIII	Indian Pharmacopoeia (IP 2014)
1.	Pharmacopoeial Title	√	√	√	√	√
2.	Definition-Botanical Name (family), Part used as distribution	√	√	√	Botanical Name, Family, Part used, Distribution are under independent headings	√
3.	Synonyms	√	√	√	√	√
4.	Regional Language Name	√	√	√	Common Names	–
5.	Description Macroscopic Microscopic Powder	√	√	√	Description-Macroscopic Microscopic Powder-independent headings	–
6.	Identity, Purity & Strength	√	√	√	–	–
	Foreign Matter	√	√	√	–	√
	Total Ash	√	√	√	–	√
	Acid insoluble ash	√	√	√	–	√
	Alcohol/ethanol soluble extractive	√	√	√	–	√
	Water soluble Extractive	√	√	√	–	√
	Loss on drying	–	√	–	–	√
	Heavy metals	–	√	–	–	√
	Microbial contamination	–	√	–	–	√
	Pesticide residues	–	√	–	–	–
	Aflatoxins	–	√	–	–	–
7.	Assay	√	√	–	–	√
8.	Thin Layer Chromatography	√	√	√	In certain monographs	√
9.	Constituents	√	√	√	–	–

Sl. No.	Quality Specification	Unani Pharmacopoeia of India, Part-I (UPI) Volume-I	Ayurvedic Pharmacopoeia of India, Part-I (API) Volume-I & VIII	Siddha Pharmacopoeia of India, Part-I (SPI) Volume-I	Homoeopathy Pharmacopoeia of India (HPI) Volume-I & VIII	Indian Pharmacopoeia (IP 2014)
10.	Properties and Action (as per system of medicine)	√	√	√	–	Category
11.	Important Formulations	√	√	√	–	–
12.	Therapeutic Uses	√	√	√	–	–
13.	Dose	√	√	√	–	–
14.	Identification	–	–	–	√	Macroscopic Microscopic & TLC
15.	History and authority	–	–	–	√	–
16.	Preparation	–	–	–	√	–
17.	Heavy metals	–	–	–	√	√
18.	Loss on drying	–	–	–	√	√
19.	Microbial contamination	–	–	–	√	√
20.	Storage	–	–	–	√	√

Table 3: Comparative account of pharmacopoeial standards on *Withania somnifera* (L.) Dunal published various edition of Indian Pharmacopoeia.

Sl. No.	Quality Specification	Unani Pharmacopoeia of India (UPI), Part-I, Volume-I	Ayurvedic Pharmacopoeia of India (API), Part-I, Volume-I & VIII	Siddha Pharmacopoeia of India (SPI), Part-I, Volume-I	Homoeopathy Pharmacopoeia of India (HPI) Volume-I & VIII	Indian Pharmacopoeia (IP 2014)
1.	Official Title	Asgand	Asvagandha	Amukkara	<i>Withania somnifera</i> (With. Som.)	Ashwagandha Indian Ginseng; <i>Withania somnifera</i>
2.	Botanical Species	<i>Withania somnifera</i> Dunal.	<i>Withania somnifera</i> (L.) Dunal.	<i>Withania somnifera</i> (L.) Dunal.	<i>Withania somnifera</i> Dunal.	<i>Withania somnifera</i> (L.) Dunal.
3.	Synonyms	–	–	<i>Physalis somnifera</i> L., <i>P. flexuosa</i> L., <i>P. arborescens</i> DC.	<i>Physalis somnifera</i> L., <i>P. flexuosa</i> L.	–

Sl. No.	Quality Specification	Unani Pharmacopoeia of India (UPI), Part-I, Volume-I	Ayurvedic Pharmacopoeia of India (API), Part-I, Volume-I & VIII	Siddha Pharmacopoeia of India (SPI), Part-I, Volume-I	Homoeopathy Pharmacopoeia of India (HPI) Volume-I & VIII	Indian Pharmacopoeia (IP 2014)
4.	Morphological part/Official part	Dried mature roots	Dried mature roots	Dried roots	Root	Root
5.	Description	I. Macroscopic II. Microscopic	I. Macroscopic II. Microscopic III. Powder	I. Macroscopic II. Microscopic III. Powder	I. Macroscopic II. Microscopic	I. Macroscopic II. Microscopic
6.	Identity, Purity & Strength					
	Foreign Matter	2.0 %, Not more than	2.0 %, Not more than	2.0 %, Not more than	–	2.0 %, Not more than
	Total Ash	7.0 %, Not more than	7.0 %, Not more than	7.0 %, Not more than	–	7.0 %, Not more than
	Acid insoluble ash	1.0%, Not more than	1.0%, Not more than	1.0%, Not more than	–	1.2%, Not more than
	Alcohol/ ethanol soluble extractive	15.0%, Not less than*	15.0%, Not less than* (Vol. VIII)	15.0%, Not less than	–	10.0%, Not less than
	Water soluble Extractive	–	7.0%, Not less than (Vol. VIII)	27.0%, Not less than	–	15.0%, Not less than
	Loss on drying	–	12.0 %, Not more than	–	–	12.0%, Not more than
	Heavy metals	–	Pharmacopoeial limits (Vol. VIII)	–	–	Pharmacopoeial limits
	Microbial contamination	–	Pharmacopoeial limits (Vol. VIII)	–	–	Pharmacopoeial limits
	Pesticide residues	–	Pharmacopoeial limits (Vol. VIII)	–	–	–
Aflatoxins	–	Pharmacopoeial limits (Vol. VIII)	–	–	–	
7.	Assay	Total alkaloids- 0.2 % Not less than	Total alkaloids- 0.2 % Not less than	Assay by HPLC, Quantification not given	–	Total withanoloid- 0.2 % Not less than
8.	Chromatography (TLC/HPTLC/ HPLC)	TLC profile	TLC/HPTLC profile (Vol. VIII)	TLC profile	–	TLC profile

*Alcohol (25 percent) soluble extractive

Pharmacopoeia (IP) is the first official pharmacopoeia having its first edition in the year 1955 followed by the publication of other pharmacopoeias viz. Ayurvedic Pharmacopoeia of India (1986), Unani Pharmacopoeia of India (1998), Siddha Pharmacopoeia of India (2008b) and Homoeopathic pharmacopoeia of India (1971). All these Pharmacopoeias provide regulatory standards under Drugs & Cosmetics Act 1940 & Rules thereunder for quality control of drugs of

Table 4: Comparative account of pharmacopoeial standards on *Withania somnifera* (L.) Dunal published other Pharmacopoeias

Sl. No.	Quality Specification	American Herbal Pharmacopoeia (AHP) 2000	British Pharmacopoeia (BP) 2013	The United States Pharmacopoeia (USP 36/NF 31) 2013
1.	Official Title	Asvagandha Root	Withania Somnifera Root	Asvagandha Root
2.	Botanical Species	<i>Withania somnifera</i> (L.) Dunal.	<i>Withania somnifera</i> (L.) Dunal.	<i>Withania somnifera</i> (L.) Dunal.
3.	Morphological part/ Official part	Dried root	Dried mature root	Dried mature root
4.	Description	I. Macroscopic II. Microscopic III. Powder	I. Macroscopic II. Microscopic	I. Macroscopic II. Microscopic III. Powder
5.	Identity, Purity & Strength			
	Foreign Matter	2.0%, Not more than	–	2.0%, Not more than
	Total Ash	7.0%, Not more than	7.0%, Not more than	7.0%, Not more than
	Acid insoluble ash	1.0%, Not more than	1.0%, Not more than	1.0%, Not more than
	Alcohol/ethanol soluble extractive	–	–	10.0%, Not less than
	Water soluble Extractive	–	–	–
	Loss on drying	10.0%, Not more than	12.0%, Not more than	12.0%, Not more than
	Heavy metals	-	-	Pharmacopoeial limits
	Microbial contamination	Pharmacopoeial limits	-	Pharmacopoeial limits
	Pesticide residues	-	-	Pharmacopoeial limits
	Aflatoxins	-	-	Pharmacopoeial limits
6.	Assay	Total alkaloids-0.2% Not less than	Withaferin A-0.1% Not less than and Withanolide 0.1% Not less than	Withanolides- 0.3% Not less than
7.	Chromatography (TLC/HPTLC/HPLC)	HPLLC profile	TLC profile	TLC profile

Ayurvedic, Siddha, Unani, Homoeopathic and modern systems of medicine. Pharmacopoeial standards on *W. somnifera* (L.) Dunal. in respect of total ash, acid insoluble ash, alcohol/ethanol soluble extractives and water soluble extractive varies in different pharmacopoeial monographs (Table-6). To facilitate uniformity in regulatory quality specifications, harmonization of pharmacopoeial standards is very much needed when acceptability of herbal drugs in uniform manner is accelerating (Rai and Sharma, 2014).

Table 5: Comparative account of pharmacopoeial standards on *Withania somnifera* (L.) Dunal published on non Pharmacopoeial.

Sl. No.	Quality Specification	Indian Herbal Pharmacopoeia (IHP) 2002	Quality Standards of Indian Medicinal Plants (QCIMP) 2011
1.	Official Title	<i>Withania Somnifera</i>	<i>Withania somnifera</i> (L.) Dunal.(Asvagandha)
2.	Botanical Species	<i>Withania somnifera</i> (L.) Dunal.	<i>Withania somnifera</i> (L.) Dunal.
3.	Synonyms	<i>Physalis somnifera</i> L., <i>P. flexuosa</i> L., <i>P. arborescens</i> DC.	<i>Physalis somnifera</i> L.
4.	Morphological part/ Official part	Dried roots	Dried roots
5.	Description	I. Macroscopic II. Microscopic	I. Macroscopic II. Microscopic III. Powder
6.	Identity, Purity & Strength		
	Foreign Matter	2.0%, Not more than	1.0%, Not more than
	Total Ash	7.0%, Not more than	8.0%, Not more than
	Acid insoluble ash	1.2%, Not more than	2.0%, Not more than
	Alcohol/ethanol soluble extractive	20.0%, Not less than 20.0%, Not less than*	18.0%, Not less than
	Water soluble Extractive	–	22.0%, Not less than
7.	Assay	Quantification not given	Withaferine A - 0.036 to 0.094
8.	Chromatography (TLC/HPTLC/HPLC)	HPLC profile	TLC/HPLC profile

*Alcohol (25 percent) soluble matter.

Pharmacopoeial standards on *W. somnifera* (L.) Dunal. incorporated in various pharmacopoeias are required to be harmonized with the monographs appeared in other contemporary pharmacopoeias. The quality of herbal drugs is always prime issue and dealt with regulatory provisions of pharmacopoeial monographs. The harmonized pharmacopoeial monographs will be yardstick to ensure the quality, safety and efficacy of herbal drugs without any ambiguity.

References

Anonymous, 1940. Drugs & Cosmetics Act and Rules, Govt. of India, Ministry of Health & Family Welfare, New Delhi.

Table 6: Variation in standards in respect of Pharmacopoeial standards.

Sl. No.	Quality Specification	Unani Pharmacopoeia of India (UPI), Part-I, Volume-I	Ayurvedic Pharmacopoeia of India (API), Part-I, Volume-I & VIII	Siddha Pharmacopoeia of India (SPI), Part-I, Volume-I	Homoeopathy Pharmacopoeia of India (HPI) Volume-I & VIII	Indian Pharmacopoeia (IP 2014)
1.	Foreign Matter	2.0%, Not more than	2.0%, Not more than	2.0%, Not more than	–	2.0%, Not more than
2.	Total Ash	7.0%, Not more than	7.0%, Not more than	7.0%, Not more than	–	7.0%, Not more than
3.	Acid insoluble ash	1.0%, Not more than	1.0%, Not more than	1.0%, Not more than	–	1.2%, Not more than
4.	Alcohol/ ethanol soluble extractive	15.0%, Not less than	15.0%, Not less than (Vol. VIII)	15.0%, Not less than	–	10.0%, Not less than
5.	Water soluble Extractive	–	7.0%, Not less than (Vol. VIII)	27.0%, Not less than	–	15.0%, Not less than
6.	Microbial contamination	–	Pharmacopoeial limits (Vol. VIII)	–	–	Pharmacopoeial limits
7.	Pesticide residues	–	Pharmacopoeial limits (Vol. VIII)	–	–	–
8.	Aflatoxins limits (Vol. VIII)	–	Pharmacopoeial	–	–	–
9.	Assay	Total alkaloids- 0.2% Not less than	Total alkaloids- 0.2% Not less than	Quantification not given	–	Total withanoloid- 0.2% Not less than

Anonymous, 1955. Pharmacopoeia of India (The Indian Pharmacopoeia) first ed., Govt. of India, Ministry of Health and Family Welfare, New Delhi.

Anonymous, 1966. Pharmacopoeia of India (The Indian Pharmacopoeia) second ed., Govt. of India, Ministry of Health and Family Welfare, New Delhi.

Anonymous, 1971. Homoeopathic Pharmacopoeia of India Vol. I. Government of India, Ministry of Health & Family Welfare, New Delhi.

Anonymous, 1976. The Wealth of India (Raw Materials), Vol. X (Sp-W). C.S.I.R., New Delhi.

Anonymous, 1986. The Ayurvedic Pharmacopoeia of India, Part- I, Volume-I, First edition, Govt. of India, Ministry of Health & Family Welfare, New Delhi, pp.15-16.

Anonymous, 1996. Pharmacopoeia of India (The Indian Pharmacopoeia) Vol-I&II. Fourth ed. Manager of Publications, Govt. of India, New Delhi.

Anonymous, 1998. The Unani Pharmacopoeia of India, Part-I, Vol.-I, Govt. of India, Ministry of Health & Family Welfare, New Delhi pp. 7-8.

- Anonymous, 2000a. Homoeopathic Pharmacopoeia of India Vol. VIII. Government of India, Ministry of Health & Family Welfare, New Delhi, pp.136-37.
- Anonymous, 2000b. American Herbal Pharmacopoeia and Therapeutic Comendium-Aswgandha root, Published by ABC, USA, pp. 1-24.
- Anonymous, 2002. Indian Herbal Pharmacopoeia. Revised New Edition. Published by IDMA-Mumbai, pp. 2479-2481.
- Anonymous, 2007. Pharmacopoeia of India (The Indian Pharmacopoeia) Vol- I, II& III. Fifth ed. The Indian Pharmacopoeia Commission, Govt. of India, Ministry of Health and Family Welfare, New Delhi.
- Anonymous, 2008a. The Ayurvedic Pharmacopoeia of India, Part- I, Volume– VIII, First edition, Govt. of India, Ministry of Health & Family Welfare, New Delhi.
- Anonymous, 2008b. The Siddha Pharmacopoeia of India, Part-I, Vol.-I, Govt. of India, Ministry of Health & Family Welfare, New Delhi, pp. 1-3.
- Anonymous, 2010. Pharmacopoeia of India (The Indian Pharmacopoeia) Vol- I, II& III. sixth ed. The Indian Pharmacopoeia Commission, Govt. of India, Ministry of Health and Family Welfare, New Delhi.
- Anonymous, 2011. Quality Standard of Indian Medicinal Plants, Vol. IX. Indian Council of Medicinal Research. New Delhi, pp. 356-367.
- Anonymous, 2013a. (The United States Pharmacopoeia/National Formulary)USP 36/NF 31, 2013 Vol. – 1, Published by the United States Pharmacopoeial Contention, Rockville, USA.
- Anonymous, 2013b. British Pharmacopoeia, CD-ROM, pp.1-5.
- Anonymous, 2014. Pharmacopoeia of India (The Indian Pharmacopoeia) Vol- III. seventh ed. The Indian Pharmacopoeia Commission, Govt. of India, Ministry of Health and Family Welfare, New Delhi, pp. 3183-3185.
- Chopra; R.N., Nayar, S.L. and Chopra, I.C., 1956. Glossary of Indian Medicinal Plants, C.S.I.R., New Delhi.
- Chopra, R.N; Chopra, I.C; Handa, K.L. and Kapoor, L.D. 1958. Chopra's Indigenous Drugs of India. U.N. Dhur & Sons Pvt. Ltd., Calcutta.
- Kirtikar, K.R. and Basu, B.D., 1933. Indian Medicinal Plants, Vol. 1-4. L.M. Basu, Allahabad.
- Nadkarni, A.K., 1954. K.M. Nadkarni's Indian Materia Medica. ,Vol.I ,Popular Book Depot, Bombay.
- Rai, Nitin, Lalit Tiwari & Rajeev Kr. Sharma, 2012. Quality standards on medicinal plants with special reference to regulatory aspects. In: Modern Technologies for Sustainable Agriculture (eds. Birendra Prasad and Sunil Kumar). Chapter 9, pp. 147-175.

- Rai Nitin, Lalit Tiwari and Rajeev Kr. Sharma, 2013. Regulatory status of herbal drugs and related substances in Indian Pharmacopoeia (IP). *Hippocratic J. Unani Medicine* 8(2): 149-170.
- Rai Nitin and Rajeev Kr. Sharma, 2014. Harmonization of Indian Pharmacopoeial Standards. *Hippocratic J. Unani Medicine* 9(2): 75-108.
- Sharma, B.M. and P. Kachroo, 1988. Flora of Jammu and plants of neighbourhood Vol.I. Bishan Pal Singh Mahendra Pal Singh, Dehradun.
- Tiwari, Lalit; Nitin Rai and Rajeev Kr. Sharma, 2013. Regulatory Standards on Homoeopathic Drugs: Indian Perspective. *Int. J. Adv. Pharma. Sci. & Tech* 1(1): 1-20.

