

NA-230

ISSN 1391-5622

ISBN 955-8394-05-X

Medicinal and Aromatic Plant Series, No.4



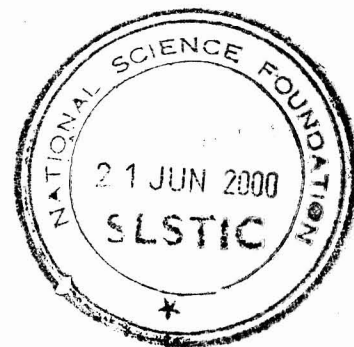
ASHWAGANDHA

(*Withania somnifera*)

Information Services Centre
Industrial Technology Institute
(Successor to CISIR)
Colombo, Sri Lanka

NA 230

Medicinal and Aromatic Plant Series, No. 4



Withania somnifera
- a literature survey -

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National Science Foundation Grant RG/IS/96/01

Published by :

**Information Services Centre
Industrial Technology Institute**

363 Baudhaloka Mawatha, Colombo 7, Sri Lanka

1999

© Industrial Technology Institute (CISIR) & National Science Foundation
First Published in 1999

National Library of Sri Lanka – Cataloguing – In – Publication Data

Jayasinha, Purnima

Ashwagandha (*Withania somnifera*) / Purnima Jayasinha;

Dilmani Warnasuriya; Harshani Dissanayake .-

Colombo : Information Services Centre, Industrial Technology Institute,
1999

Vol. 4 .- 24p. ; 28cm. .- (Medicinal and aromatic plants series)

ISBN 955-8394-05-X

Price : Rs.200.00

i. 615.321 DDC 21

ii. Title

iii. Series

iv. Warnasuriya, Dilmani jt.au.

v. Dissanayake, Harshani jt.au.

1. Medicinal plants

2. Botany, Medical

ISSN 1391-5622

ISBN 955-8394-05-X

Published by Information Services Centre, Industrial Technology Institute

The Information provided in this monograph is taken from available scientific literature.
The authors accept no liability for any damages arising from any claims contained in this
text.

Acknowledgements

The financial assistance by the National Science Foundation (grant number RG/IS/96/01) for the project is gratefully acknowledged. Sincere thanks are due to Mrs. Wathmanel Seneviratne and Mrs. Neranjani Mohottala for preparing the database. The assistance and support given by the industries during visits are greatly appreciated. The secretarial assistance of Mrs. Ramani Kapurubandara is acknowledged. Thanks are also due to Ms. Roshani Fernando for designing the cover.

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Withania somnifera

1.0 INTRODUCTION

Ashwagandha was considered as an important drug from time immemorial, and has been referred to as such in ancient ayurvedic literature. The word ashwagandha indicates the equine odour of the plant. The root is widely used in ayurveda and was prescribed for hiccup, female disorders, cough, rheumatism and dropsy, and as a sedative in cases of senile debility.

The roots are collected from both wild and cultivated plants. The cultivated plants are reported to differ from the wild ones not only in their morphological characters but also in their therapeutical action, though the alkaloids present are the same in both. In view of this some botanists have differentiated the cultivated from the wild one and have given it a new specific name, *Withania ashwagandha* Kaul.

2.0 BOTANY ^{21,27,28,45,63}

2.1 TAXONOMY

Family : Solanaceae
Genus : *Withania*
Species : *somnifera*

Botanical Names

Withania somnifera Linn. ; *Physalis somnifera* Linn.; *Physalis flexuosa* Linn.;
Physalis arborescens Thunb.; *Physalis tomentosa* Thunb.

Other names

Sinhala : Amukkara, Asgondu
Tamil : Amukkiray, Asubam, Ashvagandi
English : Winter Cherry, Indian Ginseng
Sanskrit : Ashvagandha
Trade Name : Ashvagandha

2.2 PLANT DESCRIPTION

A small, semi-shrubby perennial herb with long tapering roots and branched stems covered with mealy-stellate pubescence about 30-150 cm in height. Leaves are simple, alternate, often in unequal pairs, ovate, 5-8.7cm long: suddenly tapering to base, subacute, entire, shining and apparently glabrous but really covered with minute stellate or scaly hair, rather thick. Those in floral region are smaller. Flowers are regular, bisexual, small, pale green or luid-yellow, on short pubescent pedicels, usually about 5 in umbellate cymes, sepals 5, fused into a companulate. Fruit is a small berry enclosed in an inflated membranous calyx about 6-7mm across, green when unripe, orange-red when mature. Slightly 5-angled pointed by connivent segments, scurfy pubescent, 1 chambered. Numerous small capsicum like seeds are yellow in colour.

3.0 HABITAT ^{21,27,45,63}

It is a cosmopolitan plant and grows throughout the drier and sub-tropical parts of India, Sri Lanka, Mediterranean regions, Cape of Good Hope and South Africa. It is a common weed on cultivated land in Sri Lanka.

4.0 AGRONOMY ^{1,20,38,40,69}

4.1 SOIL AND CLIMATE

Withania somnifera is a herb that grows well in the dry zone in Sri Lanka. It can be cultivated in soils that are unsuited for other crops and requires little care.

It can be easily cultivated with seeds. Seeds from well matured berries should be first washed with diluted condense (diluted KI.) solution. They are sown broadcast in a nursery just before onset of rainy season. Five kilograms of seeds are sufficient to provide seedlings for a hectare.

In recent studies, seeds of *Withania somnifera* had exhibited 70-80% germination with the application of indole acetic acid (IAA), Gibberellic acid or thiourea alone or in combination with mechanical scarification at 25°C. Nutrient solution and soaking in water alone or subsequent to mechanical scarification enhanced the germination to over 50%. The germination was better at pH 7 in surface sown seeds and at field capacity in water saturated conditions.

Maximum germination was also found in seeds exposed to 8 h darkness, and minimum in those seeds exposed to 10 h light and 14 h total darkness. Germination was maximum in blue light followed by green light and minimum in red light.

Field Planting

When the seedlings are sufficiently tall, about 10 cm they are ready to plant in the field. They are planted in holes about 30-45 cm deep and at a distance of 60 cm x 60 cm. The holes should be filled with soil well mixed with compost and dry cow dung before planting. Plants should be watered daily in the early stages. But it is not necessary after they have grown. Excessive rain is harmful, as it leads to excessive weed-growth.

4.2 MANURING

Fertilizer should be added in 3 stages :

- (1) Six months after planting
- (2) Ten months after planting
- (3) Fifteen months after planting

One to two coconut shells full of dry cow dung and compost are added round the plant in 180-240 cm radius and the soil is loosened.

Nitrogenous fertilizers promote heavy leafy growth with low yield of roots. But field trials have shown that the highest root yield of 6.81 q/ha was obtained by fertilizing at 30kg N/ha.

4.3 HARVESTING

Harvesting should be done after 18 months. Sometimes the time period can vary due to climate conditions.

Recent experiments have shown that the green yield was highest at full bloom and alkaloid contents were highest at the beginning of flowering.

The harvesting is done by uprooting the whole plant. Roots are separated from the aerial parts by cutting the stem about 1-2 cm above the crown. They are then transversely cut into smaller pieces for drying. Occasionally, the roots are dried whole. Drying is done in mild sun or in the shade.

The dried whole roots undergo cleaning, trimming and grading before dispatch. They are beaten with a club to remove adhering soil and thin lateral rootlets. The main tap root may be cut into transverse pieces. Then it is carefully hand-sorted into four grades, based on thickness and uniformity of pieces. The fourth grade consists of thin and wiry roots, rarely exceeding 3 mm diameter and are practically useless as a drug.

4.4 TISSUE CULTURE OF *Withania somnifera*

Tissue culture of Amukkara is done at Plant Genetic Resources Centre at Gannoruwa, Peradeniya. Axillary buds, terminal buds, leaf pieces of the plant are used as explants. A medium containing benzyl amino purin (BAP) (1mg/l) and naphthalene acetic acid (NAA) (0.1 mg/l) is used to obtain multiple shoot. This, when transferred to Murashige & Skoog's (MS) with NAA (1mg/l) gives rooted plantlets. The plantlets then can be transferred to soil under controlled conditions.

In Bhabha Atomic Research Centre, India, tissue cultures were established from axillary meristems of the plant. Morphogenetic responses of the cultures were influenced by growth hormones. The explants in Murashige & Skoog's (MS) medium is used to obtain multiple shoots and rootings in MS + coconut milk (10%). The callus formation was done in MS + 2,4-dichlorophenoxyacetic acid (2.0ppm). Here the callus cultures failed to synthesize withanolides. But the multiple shoot cultures synthesized significant levels of withanolides and their concentrations varied with different growth hormones.

The plant is highly polymorphic and exhibits great genetic diversity in nature. Different chemotypes of *Withania somnifera* have been found to occur in Israel. They show a definite geographical distribution, but no morphological differences. The difference between these chemotypes resides in the substitution pattern of the withanolides.

Indian plants differ from the known chemotypes of Israel in the composition of withanolides. A different pattern of withanolides was found in the South African plants.

4.5 DISEASES AND PESTS ^{38,90}

Damping off is a major disease of *Withania somnifera* which results in heavy seedling mortality. Dithane M-45 at 0.5% concentration used as seed dressing and soil disinfection were found to be most suitable for this disease.

Under field conditions, the plant is subject to leaf blight, die back seed rot and infestation by mites, aphids and ladybird beetle (*Epilachna vigintioctopunctata*). Cultivated types were found more susceptible to fungal infections, whereas wild types were prone to mites and insect pests.

A combination of 0.5% malathion and 0.1-0.3% Kelthane as foliar spray at 10-15 day intervals was found highly useful against mites and insect attacks. Leaf blight is checked to some extent by 0.3% Dithane M-45 foliar sprays.

5.0 CHEMISTRY OF PLANT ^{9,10,14,28,41,50,63,100,119}

5.1 CHEMICAL CONSTITUENTS OF PLANT

Steroids

1. 24-ethyl cholest-5,22-dien-3 β -01
2. 24-ethyl cholest-5-en-3 β -01
3. 24-ethyl cholest-5(z),24(28)-diene-3 β -01
4. 24-methyl cholesta-5,24(25)-diene-3 β -01
5. 20,28-dihydroxy-1-oxo-witha-2,5,8(14),24-tetraenolide
6. Withaferin A
7. Withaferinil
8. Withaferinol A
9. Withanolide D
10. 5-dehydroxy withanolide R
11. Withasomniferin A
12. 27-hydroxy.3-oxo-22(R)-witha-1,4,24-trienolide (Withasomidienone)

Mineral elements from dried plant material

Ca - 1.282%	Cu - 0.00053%	Fe - 0.02654%
Mg - 0.0993%	Zn - 0.0036%	Ba - 0.00019%
K - 0.384%	Na - 0.04%	Al - 0.0794%
Ce - 0.0246%	Sr - 0.0548%	V - 0.00007%
Co - 0.00017%	Ag - 0.00003%	

5.2 CHEMICAL CONSTITUENTS OF LEAVES

Withania somnifera shows a chemical variability, particularly noticeable in the case of leaves. The leaves of the plant from different habitats contain different withanolides. There seems to be a greater concentration of withanolides in the leaves at the stage of maximum vegetative development.

Steroids

1. 4 β , 20 α -(R) – With-2-enolide
2. 4 β -hydroxy-1-oxo-5 β ,6 β -epoxy-with-2-enolide
3. 1 α ,3 β ,5 α -trihydroxy-6 α ,7 α -epoxy-22(R)-with-24-enolide
4. 5 α ,27-dihydroxy-1-oxo-6 α ,7 α -epoxy-22(R)-witha-2,24-dienolide
5. 4 β ,20 α -dihydroxy-1-oxo-5 β ,6 β -epoxy-witha-2,24-dienolide
6. 14 α -hydroxy withanolide D
7. 17 α -hydroxy withanolide D
8. 27-hydroxy-withanolide D
9. 7 β -hydroxy-withanolide D
10. 2,3-dihydroxy-withanolide D
11. 5 α ,17 α -dihydroxy-1-oxo-6 α ,7 α -epoxy-witha-2,24-dienolide
12. 4 β ,17 α -dihydroxy-1-oxo-5 β ,6 β -epoxy-22(R)-witha-2,24-dienolide
13. 5,27-dihydroxy-1-oxo-5 β ,6 β -epoxy-22(R) –witha-2,24-dienolide
14. 5,20(R)-dihydroxy-1-oxo-6 α ,7 α -epoxy-5 α -witha-2,24-dienolide
15. 4 β -hydroxy-1-oxo-5 β ,6 β -epoxy-22(R)-witha-2,14,24-trienolide
16. 17 α ,27-dihydroxy-1-oxo-22(R)-witha-2,5,24-trienolide
17. 7 α ,27-dihydroxy-1-oxo-22(R)-witha-2,5,24-trienolide
18. 5 α ,17 α -dihydroxy-1-oxo-witha-2,6,24-trienolide
19. 5,17-dihydroxy-1-oxo-6 α ,7 α -epoxy-22(R)-2,6,24-trienolide
20. 17,27-dihydroxy-1-oxo-22(R)-witha-2,5,24-trienolide
21. 17 α ,27-dihydroxy-1-oxo-20(R),22(R)-witha-2,5,14,24-tetranolide(withanolide N)
22. 4 β ,17 α -dihydroxy-1-oxo-20(R),22(R)-witha-2,5,8(14),24-tetranolide(withanolide O)
23. Withanolide E
24. 4 β -hydroxy withanolide E
25. Withanolide F
26. Withanolide G
27. Withanolide H
28. Withanolide J
29. Withanolide K
30. Withanolide L
31. Withanolide M
32. Withanolide P
33. Withanolide Q
34. Withanolide R
35. Withanolide S
36. Withaferin
37. Withaferin A
38. 27-deoxy withaferin
39. 14 α -hydroxy-27-deoxy-withaferin A
40. 17 α -hydroxy-27 deoxy-withaferin A
41. 2,3-hydro withaferin A
42. dihydro withaferin
43. withanicandrin
44. β -sitossterol
45. 4-deoxy-physalolactone
46. Somnisol

47. Somnitol
48. Withacnistin

Alkaloid

1. Withasomnine

Amino acids

- | | |
|----------------------|------------------|
| 1. Glycine | 5. Cystine |
| 2. α -ananine | 6. Glutamic acid |
| 3. α -alanine | 7. Proline |
| 4. Teytophane | |

- | | |
|------------------|----------------------|
| 1. Withanic acid | 3. Condensed tannins |
| 2. Flavanoids | 4. Chlorogenic acid |

- | | |
|------------------------------------------|---------------------------|
| 1. 6,8-dihydroxy kaempferol-3-rutinoside | 5. Quercetin |
| 2. Quercetin-3-0-rutinoside | 6. Quinic acid |
| 3. Quercetin-3-rutinoside-7-glucoside | 7. 4-0-caffeoylquiic acid |
| 4. 4-5-0-caffeoylquinic acid | |

From the leaves of chemotype III from Israel, several chlorinotral withanolides have been isolated.

1. 4-D-deoxyphysalolactone
2. 5 β -0H-6 α -Cl-Withanolide D
3. 6 β -0H-5 α -Cl-Withanolide E (Withanolide C)

5.3 CHEMICAL CONSTITUENTS OF ROOT

The roots are dark brown with creamy interior. They are straight, unbranched and conical. The main roots bear fibre-like secondary roots. The pharmacological activity of the roots is due to the presence of alkaloids. The total alkaloid content of the Indian roots has been reported to vary between 0.13 and 0.31% though much higher yields have been recorded elsewhere. The variations in the yield might be due to factors, such as methods of isolation used, variability in species, environment and wild or cultivated forms.

Alkaloids

- | | |
|------------------------------------|------------------------|
| 1. Anaferine | 7. Anahygrine |
| 2. Choline | 8. Cuscohygrine |
| 3. Iso – pelletierine | 9. 3-troppytl tigloate |
| 4. 3 α -tigloyl-oxy-tropane | 10. Tropine |
| 5. Pseudo-tropine | 11. Withasomine |
| 6. Visamine | 12. Nicotine |

Steroids

1. $5\alpha,17\alpha$ -dihydroxy-1-oxo- $6\alpha,7\alpha$ -epoxy-22(R)-with a-2,24-dienolide
2. Withaferin A
3. Withanolide
4. Withanol
5. β -sitosterol

Amino acids

1. Glycine
2. Tyrosine
3. Proline
4. Glutamic acid
5. Aspartic acid
6. Alanine
7. Tryptophan
8. Cystine

Fatty acids

starch

reducing sugars

essential oils

5.4 CHEMICAL COMPOSITION OF SHOOT

1. Withanone
2. Withanolide E
3. Withanolide I
4. Withanolide D
5. Withanolide G

5.5 CHEMICAL COMPOSITION OF SEED AND SEED OIL

Specific gravity 31°C - 0.8957

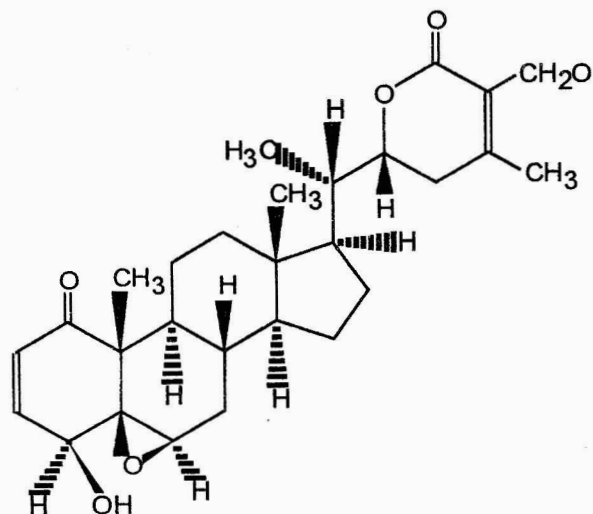
N_{D}^{20} - 1.4660

Acid value	-	2.8
Iodine value	-	158.2
Free fatty acid	-	14%
Lauric acid	-	0.07%
Myristic acid	-	0.14%
Palmitic acid	-	17.45%
Stearic acid	-	3.71%
Oleic acid	-	20.18%
Linoleic acid	-	58.82%

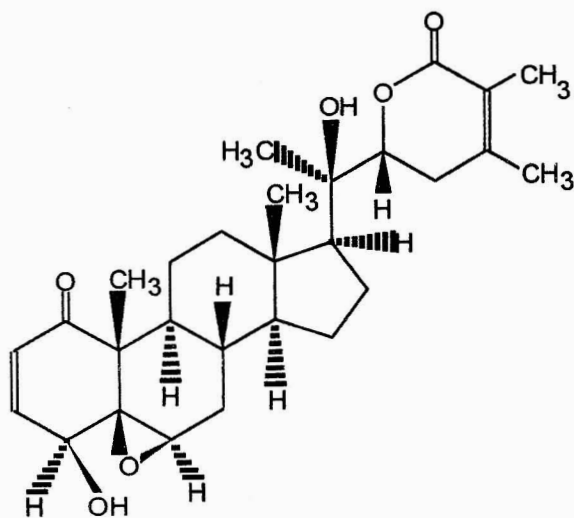
Withanolid WS 1

Withaferin A

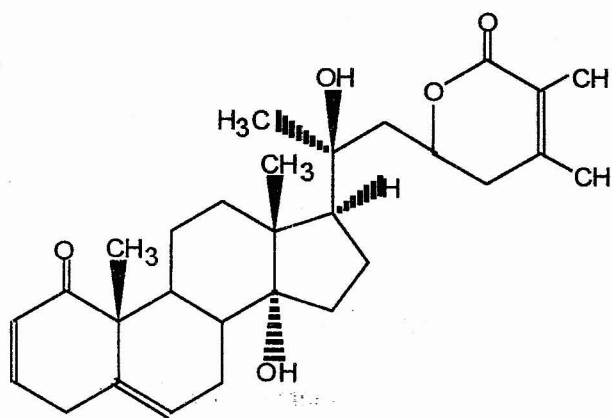
$5\alpha,17\alpha$ -dihydroxy-1-oxo- $6\alpha,7\alpha$ -epoxy witha-2,24-dienolide



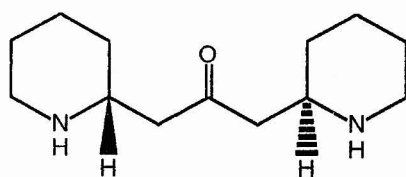
Withaferin A



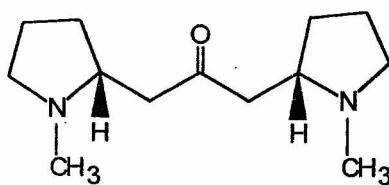
Withanolide D



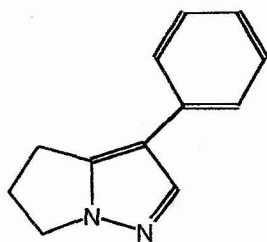
Withanolide E



(-) - Anaferine



Cuscohygrine



Withasomnine

Figure 1. Chemical Constituents of *Withania somnifera*

6.0 BIOLOGY AND HEALTH ASPECTS ^{2,19,28,30,31,41,45,59,63,68,101,113,114,115,119}

6.1 BIOACTIVITY OF *Withania somnifera*

Withania somnifera is reported to be abortifacient, adaptogenic, alterative, amoebicide, antiarthritic, antibiotic, anti-inflammatory, anti-tumor, anodyne, aphrodisiac, astringent, bactericide, contraceptive, diuretic, emmenagogue, fungicide, hypotensive, narcotic, pediculicide, poison, sedative, spasmolytic and tonic.

The total alkaloids produced a taming and a mild depressant effect (tranquillizer-sedative type) on the central nervous system in several experimental animals. The neuro-pharmacological activity was accredited to the acetone-soluble fraction of the total alkaloids. In another experiment, the depressive effect was attributed to the basic alkaloids in the roots.

For its central nervous system (CNS) depressant properties, *Withania somnifera* is used in the Indian system of medicine for insanity, epilepsy, and hypertension. The methanolic extract of its roots has been shown to potentiate pentobarbitene-induced hypnosis and pentylenetetrazol (PTZ) - induced seizure latency. In the kindling model of epilepsy, mice pretreated with *Withania somnifera* root extract experienced a significant protection.

Ashwagandha also show CNS effects including antistress, antianxiety and CNS inhibitory putative neurotransmitter GABA or the anxiolytics benzodiazepines.

The total alkaloids showed relaxant and antispasmodic effects against several spasmogens on intestinal, uterine, bronchial, tracheal and blood-vascular muscles. The pattern of smooth muscle activity of the alkaloid was similar to that of papavorine which suggested a direct musaculotropic action. This activity lends credence to the use of ashwagandha in asthma and as a uterine sedative in ayurvedic systems of medicine.

The plant extract induced a significant decrease in the arterial and diastolic blood pressure in 'normotensive' pentobarbital anaesthezied dogs. It also prevented the

hypotensive effect acetylcholine and increased the hypertensive effect of adrenaline and increased the hypertensive effect of adrenaline.

Alkaloids of roots exhibited prolonged hypotensive, bradyardiac and respiratory-stimulating action in dogs. The hypotensive effect is due mainly to autonomic ganglion-blocking action.

Vasamine, an alkaloid, prolonged hexenal-induced sleeping time, and had hypothermic and nicotinolytic effects in mice. (LD₅₀ in mice is 125 mg/kg body wt.)

Alcoholic extract of the drug produced good response against mouse tumor, sarcoma 180. In combination with γ -radiation and hyperthermic treatment, ashwagandha significantly increased the tumor case, growth delay of partially responding tumors and animal survival.

Experiments on the tumor inhibitory effects of the crude root extract and a purified compound, withaferin A, using two transplanted mouse tumors *in vivo* and a mammalian cell line *in vitro*, produced a cytotoxic effect and inhibited tumour growth. The effect increased with the drug dose. Mice tolerated daily doses of 750 mg/kg body weight, for 10-15 days without any adverse health effects.

Withaferin A inhibited the growth of Ehrlich carcinoma in Swiss mice and rendered the cured animals refractory to reinoculation with the same tumour regression during withaferin A treatment. This was found to be due to immune activation characterized by the presence of circulating antibodies with cytotoxic properties towards Ehrlich ascites cells.

Withaferin A and withanolide D (40 μ g/ml) inhibited RNA formation by sarcoma 180 tumour cells whereas withaferin A inhibited formation also, withanolide D caused a slight stimulation of protein synthesis.

The plant extract is active against *Entamoeba histolytica* and against Ranikhet and vaccinia viruses. The leaf and root have shown marked antibiotic activity against *Staphylococcus aureus*, the leaf being the more active.

Withaferin A, 4 β -hydroxywithanolide E and Withaphysocarpin exhibited a significant antibacterial effect against gram-positive organisms at 6-100 μ g/ml concentration, while 27-deoxywithaferin A, 2,3-dihydroxywithanolide E, withanolide E and withacandrin were active at 100-200 μ g/ml.

The plant has milk clotting properties. The possibility of its use in cheese-making has been discussed.

When alcoholic extracts from the roots of *Withania somnifera* were screened for their acute (24 h) toxicity in conventional swiss albino mice and subacute toxicity (30 days) in wistar rats, a single intraperitoneal injection of 1100 mg/kg of the extraction in mice did not produce any deaths within 24 h, but small increases led to mortality. The LD₅₀ value was calculated as 1260 mg/kg body weight.

A recent study in investigating the immunomodulatory effects of *Withania* in animal models showed that it may act as an immuno-stimulatory agent even in healthy

individuals, and support the traditional use of the herb in various immunological and other disorders, and as a health tonic for normal individuals.

Methanol extract of *Withania somnifera* roots inhibited the specific binding of {3H} GABA. And {35S} TBPS, and enhanced the binding of {3H} flunitrazepam to their putative receptor sites. In functional studies utilizing ³⁶Cl-influx assay in mammalian spinal cord neurons, an extract of *Withania somnifera* root increased ³⁶Cl-influx in the absence of GABA. This effect on ³⁶Cl-influx was blocked by bicuculline and picrotoxin, and enhanced by diazepam. These results suggested that an extract of *Withania somnifera* contains an ingredient which may possess GABA mimetic activity.

Table 1 : Antibacterial activity of *Withania somnifera*

Extract	Medium	Dose	Organism
Acetone	Agar plate	50% conc ^a	<i>Neurospora crassa</i>
Methanol	Agar plate	-	<i>Escherichia coli</i>
Methanol	Agar plate	-	<i>Proteus vulgaris</i>
Methanol	Agar plate	-	<i>Pseudomonas aeruginosa</i>
Methanol	Agar plate	-	<i>Salmonella species</i>
Methanol	Agar plate	5.0 mg/ml 50.0 mg/ml	<i>Staphylococcus aureus</i>
Chloroform	Agar plate	50.0 mg/ml	<i>Staphylococcus epidermidis</i>
Chloroform	Agar plate	5.0 mg/ml 1.0 mg/ml	<i>Bacillus subtilis</i>
Chloroform	Agar plate	5.0 mg/ml 1.0 mg/ml	<i>Staphylococcus aureus</i>
Chloroform	Agar plate	5.0 mg/ml 1.0 mg/ml	<i>Staphylococcus epidermidis</i>
Methanol	Agar plate	20.0 mg/ml 5.0 mg/ml 5.1 50.0 mg/ml	<i>Bacillus subtilis</i>
Methanol	Agar plate	5.0 mg/ml 20.0 mg/ml	<i>Staphylococcus epidermidis</i>
Pet.ether	Agar plate	10.0 mg/ml 5.0 mg/ml	<i>Staphylococcus aureus</i>
Pet.ether	Agar plate	10.0 mg/ml 5.0 mg/ml	<i>Staphylococcus epidermidis</i>
Pet.ether	Agar plate	5.0 mg/ml 10.0 mg/ml	<i>Bacillus subtilis</i>
*Chloroform	Agar plate	4.0 mg/ml	<i>Escherichia coli</i>
*Ethanol (95%)	Agar plate	4.0 mg/ml	<i>Bacillus subtilis</i>
*Ethanol (95%)	Agar plate	4.0 mg/ml	<i>Shigella dysenteriae</i>
*Hexane	Agar plate	4.0 mg/ml	<i>Escherichia coli</i>
*Hexane	Agar plate	4.0 mg/ml	<i>Salmonella typhosa</i>
*Hexane	Agar plate	4.0 mg/ml	<i>Shigella dysenteriae</i>

* weakly active

Table 2 : Antiviral activity of *Withania somnifera*

Extract	Medium	Dose/conc.	Organism
Ethanol-water (1:1)	Cell culture	50.0 mcg/ml	Ranikheet virus
Ethanol-water (1:1)	Cell culture	50.0 mcg/ml	Vaccinia virus
-	Plant pathogens	-	Spinach mosaic virus

Table 3 : Anti-yeast activity of *Withania somnifera*

Extract	Medium	Dose/conc.	Organism
Methanol	Agar plate	50.0 mg/ml	<i>Canolida albicans</i>
80% ethanol	Agar plate	1.0 mg/ml	<i>Canolida albicans</i>
95% ethanol	Agar plate	-	<i>Canolida albicans</i>
Chloroform	Agar plate	10.0 mg/ml	<i>Canolida pseudotropicalis</i>
Methanol	Agar plate	10.0 mg/ml	<i>Canolida pseudotropicalis</i>

Table 4 : Anti-fungal activity of *Withania somnifera*

Extract	Medium	Dose/conc.	Organism
95% ethanol	Agar plate	50%	<i>Neurospora crassa</i>
H ₂ O	Agar plate	50%	<i>Neurospora crassa</i>
Acetone	Agar plate	50%	<i>Neurospora crassa</i>

6.2 ETHNOMEDICINE ^{62,63,72,119}

6.2.1 HOME REMEDIES

The Indian name for *Withania somnifera*, "Ashwagandha" refers to the smell and strength of a horse.

Ashwagandha is a folk remedy for adenopathy, antheax, arthritis, asthma, bronchitis, cancer, canolida, cold, cough, cystitis, debility, diarrhoea, dropsy, dyspepsia, erysipelas, fever, furuncle, gynacopathy, hiccups, hypertension, inflammation, lambago, maramus, nausea, piles, proctitis, psoriasis, rheumatism, ringworm, scabies, senility, smallpox, sores, syphilis, tuberculosis, tumours, typhoid, uterosis and wounds.

The Zulu give an enema of decorticated root to feverish infants. The Tangannyikans use the root as a sexual stimulant and ecbolic. The Masai use the leaf juice for conjunctivities.

The Transvaal Sotho administers it to tone up the uterus in a woman who habitually miscarries and in order to remove retained conception products. They also take an infusion of the bark for asthma and apply an ointment of the leaf to bed-sores.

The plant has been widely used as a remedy for syphilis throughout Griqualand East, and Natal. It is also an African remedy for typhoid fever. In the Punjab, and possibly also in Sinol, the root has occasionally been employed to produce criminal abortion.

The Swati administer a decoction of the root and leaf in the treatment of infections and eruptive diseases, such as smallpox. The Zhosa make an ointment for wounds and sores by boiling the leaves in fat and administer a decoction of the root bark in asthma and other chest complaints. The green berry is bruised and rubbed into ringworm in both human beings and animals. A decoction of the root is administered for black gall-sickness.

The European in the free state applies a leaf paste to erysipelas, takes a decoction of the root for chest complaints and uses a decoction of the leaf externally and internally in the treatment of haemorrhoids.

Trebut records excellent results as a hypnotic from the use of an alcoholic preparation in emphysema, alcoholism and pulmonary tuberculosis.

The powder of the root mixed with ghee and honey in equal parts is recommended for impotency or seminal debility, it is also to be taken in the evening, followed by milk. As a nutrient and health restorative to the pregnant and old people a decoction of the root is recommended, or its powder with milk may be taken.

For bloody discharge, leucorrhoea etc., ashwagandha powder 45 grains and sugar candy 1 tola is given in cow's milk, morning and evening till cure is obtained. For spermatorrhoea, loss of strength etc., a powder consisting of ashwagandha, sugar, ghee, honey and long pepper is to be given daily, with milk and rice diet.

For lumbago, pains in the loins or small of the back, powder of ashwagandha and sugar candy, in ghee is recommended. For scrofulous and other glandular swellings fresh green roots, reduced to a paste with cow's urine or with water is heated and applied to the parts affected.

To improve the nutrition of weak children, roots, reduced to a paste is given with milk and clarified butter for a fortnight.

For control of leprosy and leucoderma, about 15 g of root powder is taken twice, daily with honey, and a paste in mustard oil is applied to the affected part.

Whole plant extracts are applied to skin as a skin cleanser.

In Israel, *Withania somnifera* is used widely, Cataplastm of fresh crushed leaves and fruits is applied externally for the cure of open wounds. Crushed leaves with olive oil are applied on swellings. Poultice of fresh leaves is applied or massaged with olive oil for rheumatism. Cataplastm of crushed leaves is applied on the affected organs for analgesic of external pains and inflammations and as a sedative.

6.2.2 AYURVEDIC PREPARATIONS ^{69,72}

Withania somnifera is tikta, kashaya, rasam ushna veeryam, katu vipakam, kapha vata haram.

Indications: Vaanam, visham, aphrodisiac, strength giving, complexion improved, in kasam, soola, pandu, white leprosy, pruritis, karappan and fatigue.

Ashwagandha is mentioned as an important drug in the ancient Ayurvedic literature. It consisted of the roots, which were prescribed for hiccup, female disorders, cough, rheumatism and dropsy, and as a sedative in cases of senile debility.

Table 5 : Some ayurvedic preparations using Ashwagandha

Preparations	Uses
Ashwagandha-arishtaya	For nervousness, palpitation, tremors, headaches, anorexia, dyspepsia, fatigue
Ashwagandha rasayana	
Ashwagandha gritha	For rheumatism, As a tonic
Ashwagandha oil	As a tonic
Balarishtaya	As a tonic, For rheumatism
Siddhajeemurtha syrup	

BIBLIOGRAPHY

1. Abraham, A., Kirson, I., Lavie, D. and Glotter, E.
The withanolides of *Withania somnifera* chemotypes I & II. *Phytochemistry* **14**(1) p.189-194 (1975)
2. Ahumada, F., Asp e, F., Wikman, G. and Hancke, J.
Withania somnifera extract. Its effect on arterial blood pressure in anaesthetized dogs. *Phytotherapy Research* **5**(3) p.111-114 (1991)
3. Ahumada, F., Trincado, M.A., Arellano, J.A., Hancke, J. and Wikman, G.
Effect of certain adaptogenic plant extracts on drug induced narcosis in female & male mice. *Phytotherapy Research* **5**(1) p.29-31 (1991)
4. Al-Hindawi, M.K., Al-Deen, I.H.S., Nabi, M.H.A. and Ismail, M.A.
Anti-inflammatory activity of some Iraqi plants using intact rats. *J.Ethnopharmacology* **26**(2) p.163-168 (1989)
5. Al-Hindawi, M.K., Al-Khafaji, S.H. and Abdul Nabi, M.H.
Anti-granuloma activity of Iraqi *Withania somnifera*. *J.Ethnopharmacology* **37**(2) p.113-116 (1992)
6. Anbalagan, K. and Sadique, J.
Withania somnifera, a rejuvenating herbal drug which controls alpha-2-macroglobulin synthesis during inflammation. *Int.J.Crude Drug Res.* **23**(4)p.177-183 (1985)
7. Ascher, K.R.S., Schmutterer, H., Glotter, E. and Kirson, I.
Withanolides and related ergostane-type steroids as antifeedants for larvae of *Epilachna varivestis*. *Phytoparasitica* **9**(3)p.197-205 (1981)
8. Asthana, R. and Raina, M.K.
Pharmacology of *Withania somnifera* (Linn.)Dunal-a review. *Indian Drugs* **26**(5) p.199-205 (1988)
9. Atta-ur-Rahman, Dur-E-Shahwar, A., Jamal, S.A. and Choudhary, M.I.
New withanolides from *Withania* species. *J.Natural Products* **56**(7)p.1000-1006 (1993)
10. Atta-ur-Rahman, Jamal, A., Choudhary, M.I. and Asif, E.
Two withanolides from *Withania somnifera*. *Phytochemistry* **30**(11) p.3824-3826 (1991)
11. Bahl, J.R. and Srivastava, H.K.
Nuclear DNA variations in *Withania somnifera* Dun and *Cassia angustifolia* Vahl. *Nuclear, India-* **30**(3) p.99-100 (1987)
12. Baxi, A.J.
Bulletin of Medico Ethnobotanical Res. **8**(1-2)p.41-47 (1987)
13. Bessalle, R., Lavie, D. and Frolow, F.
Withanolide Y, a withanolide from a hybrid of *Withania somnifera*. *Phytochemistry* **26**(6) p.1797-1800 (1987)
14. Bessalle, R. and Lavie, D.
Withanolide C, a chlorinated withanolide from *Withania somnifera*. *Phytochemistry* **31**(10) p.3648-3651 (1992)

15. Bhakare, H.A. and Khotpal, R.R.
Lipid composition of *Withania somnifera*, *Phoenix sylvestris* & *Indigofera emulphylla* seeds of Central India. *J. Food Sci. & Technology* **30**(5) p.382-384 (1993)
16. Bhattacharya, S.K., Ashok Kumar and Ghosal S.
Effects of glycowithanolides from *Withania somnifera* on an animal model of Alzheimer's disease and perturbed central cholinergic markers of cognition. *Phytotherapy Research* **9**(2) p.110-113 (1995)
17. Bhattacharya, S.K.
Evaluation of adaptogenic activity of some Indian medicinal plants. *International Seminar-Traditional Medicine*, Calcutta, 7-9 Nov.1992, p.91-93
18. Bhattathiri, V.N., Uma Devi, P., Sreelekha, T., Remani, P., Vijayakumar, T. and Nair, M.K.
Biochemical modulation of GSH by Ashvagandha relation to its usefulness as a radiosensitizer. *Int. Conf. Curr. Prog. Med. Aromat. Pl. Res.*, Calcutta, India, p.140, 30Dec.94-1Jan.95
19. Budhiraja, R.D. and Sudhir, S.
Review of biological activity of withanolides. *J.Sci. & Ind.Res.* **46**(11) p.488-491 (1987)
20. Ceylan, A. and Kaya, N.
Yield and ontogenic variability of certain alkaloid containing medicinal plants of the Aegean region. *Doga Bilim Dergisi, D2, Tarim ve Ormancilik* **7**(1) p.1-7 (1983)
21. Chopra, R.N. and Chopra, I.C.
A Review of work on Indian medicinal plants, Indian Council of Medical Research 1955
22. Choudhary, M.I. and Atta-ur-Rahman
Novel bioactive natural products from indigenous medicinal plants of Pakistan, Sri Lanka & Turkey. *7th Asian Symp. on Med. Plants, Spices & Other Nat. Prod.* Manila, 2-7 Feb.1992
23. Chourasia, H.K.
Aflatoxin contamination in drug yielding plants. *J.Indian Botanical Society* **69**(3&4) p.281-283 (1990)
24. Dafni, A. and Yaniv, Z.
Solanaceae as medicinal plants in Israel. *J.Ethnopharmacology* **44**(1) p.11-18 (1994)
25. Dahatoude, B.N., Joshi, B.G. and Vitkare, D.G.
Studies on response of nitrogen fertilization on the root yield of *Withania somnifera*. *Punjabrao Krishi Vidyapeeth Research J.* **7**(1) p.7-8 (1983)
26. Dandiya, P.C.
The pharmacological basis of herbal drugs acting on CNS. *Eastern Pharmacist* **33**(396) p.39-47 (1990)
27. Dissanayake, M.D. and Fosberg, F.R.
Flora of Ceylon (Vol VI), Amerind Publishing Co. Pvt. Ltd., New Delhi. 1987
28. Duke, A. James
CRC Handbook of medicinal herbs, CRC Press, Inc. Boca Raton, Florida. 1987

29. Dwivedi, K.K. and Singh, R.H.
A study on Ashvagandha (*Withania somnifera*). *Proceedings of the Nat. workshop on Dravyaguna*, Varanasi, India, 1992
30. Gandhi, S.S., Ticku, M.K., Binkley, P. and Mehta, A.K.
Pharmacological effects of *Withania somnifera* root extract on GABA a receptor complex. *Glimpses of Indian Ethnopharmacology* p.315-322 (1995)
31. Gandhi, S.S.
The potential of *Withania somnifera* as an antistress agent. *Update Ayurveda-94*, Bombay, India. p.16 (1994)
32. Ghosal, S., Kaur, R. and Bhattacharya, S.K.
Chemistry & bioactivity of sitoindosides IX & X. *Planta Medica* **54**(6) p.561 (1988)
33. Gill, L.S.
Solanaceae in ethnomedicinal practices of Nigeria. *J.Economic & Taxonomic Botany* **18**(2) p.329-331 (1994)
34. Glotter, E., Kirson, I., Abraham, A. and Lavie, D.
Constituents of *Withania somnifera* Dun-XIII. The withanolides of chemotype III. *Tetrahedron* **29**(10) p.1353-1364 (1973)
35. Grandhi, A., Mujumdar, A.M. and Patwardhan, B.A
Comparative pharmacological investigation of Ashwagandha and Ginseng. *J.Ethnopharmacology* **44**(3) p.131-35 (1994)
36. Gupta, O.P, Dube, C.B. and Ansari, Z.
A clinical study of ashwagandha rasayana in patients of keratitis and rough skin. *Nat. Sem .on the Use of Traditional Med. Plants in Skin Care*, CIMAP, p.8,1994
37. Gupta, R.
Indian herbs & herbal raw material-time-tested remedies for all ailments. *Indian Horticulture* **34**(4) p.39-43 (1990)
38. Gupta, S., Kumar, A. and Thakur, R.N.
Some problems in cultivation of *Withania somnifera* (L) Dunal in Jammu region of India. *J. Res. & Edu. in Indian Medicine* **12**(3) p.23-27 (1993)
39. Hazeena Begum, V. and Sadique, J.
Long term effect of herbal drug *Withania somnifera* on adjuvant induced arthritis in rats. *Indian J.Expt.Biology* **26**(11) p.877-882 (1988)
40. Hussain, F. and Ilahi, I.
Germination behaviour of *Withania somnifera* (L.) Dunal. *Hamdard Medicus* **31**(3) p.20-30 (1983)
41. Ikram, M. and Hussain, S. Fazal
Compendium of medicinal plants. Pakistan Council of Science & Industrial Research 1978
42. Inamdar, J.A., Bhat, R.B., Patel, R.C. and Gangadhara, M.
Stomatal studies in some normal & virus infected Solanaceae. *Egypt J.Bot.* **20**(1) p.75-79 (1977)
43. Jaffer, H.J., Jawad, A.L.M., Saber, H.S. and Al-Naib, A.
Evaluation of antimicrobial activity of *Withania somnifera* extracts. *Fitoterapia* **59**(6) p.497-500 (1988)

44. Jayanti, Sen and Sharma, A.K.
Micropropagation of *Withania somnifera* from germinating seeds and shoot tips. *Plant-Cell, Tissue & Organ Culture* **26**(2) p.71-73 (1991)
45. Jayaweera, D.M.A.
Medicinal Plants (Part V), National Science Council of Sri Lanka, 1982
46. Kahar, L.S., Tomar, S.S., Pathan, M.A. and Nigam, K.B.
Effect of sowing date and variety on root yield of *Withania somnifera*. *Indian J. Agricultural Sciences* **61**(7) p.495 (1991)
47. Kamernickii, A.V., Reshetova, I.G. and Krivoruchko, V.A.
Withanolides, a new type of phytosteroid. *Khimiya Prirodnykh Soedinenii* (2) p.156-186 (1977)
48. Kanadalkar, V.S., Patidar, H. and Nigam, K.B.
Genotypic association and path coefficient analysis in *Withania somnifera*. *Indian J. Genetics & Plant Breeding* **53**(3) p.257-260 (1993)
49. Kandalkar, V.S., Patidar, H. and Nigam, K.B.
Analysis of gene effects, heterosis & inbreeding depression in *Withania somnifera*. *Indian J. Agricultural Sci.* **62**(5) p.329-331 (1992)
50. Kandil, F.E., El.Sayed, N.H., Abou-Douh, A.M., Ishak, M.S. and Mabry, T.J.
Flavonol glycosides & phenolics from *Withania somnifera*. *Phytochemistry* **37**(4) p.1215-1216 (1994)
51. Karnick, C.R.
Clinical evaluation of composite Ayurvedic Drugs, on calculi, in the kidney and urinary bladder. *Aryavaidyan* **6**(2) p.104-108 (1992)
52. Karnick, C.R.
Clinical observations on the effect of composite herbal drugs on psychomotor performance in healthy volunteers. *Indian Medicine* **4**(1) p.1-4 (1992)
53. Katharia, S.K., Singh, S.P. and Kulshreshtha, V.K.A
Clinical assessment of ibuprofen and a new herbal compound in oral surgical procedures. *Indian J. Pharmacology* **24**(1) p.29-31 (1992)
54. Kirson, I. and Glotter, E.
Recent developments in naturally occurring ergostane-type steroids. A review. *J. Natural Prod.* **44**(6) p.633-647 (1981)
55. Kolhe, P.
A case of multiple sclerosis. *Deerghayu International* **10**(3) p.23-24 (1994)
56. Kulkarni, P.H.
Clinical trials of Ayurvedic formulations prepared by Purnarka (total extract) Method. *Deerghayu International* **6**(24) p.8 (1990)
57. Kulkarni, R.R.; Patki, P.S.; Jog, V.P.; Gandage, S.G. and Patwardhan, B.
Efficacy of an Ayurvedic formulation in rheumatoid arthritis: A double blind placebo controlled, cross-over study. *Indian J. Pharmacology* **24**(2) p.98-101 (1992)
58. Kulkarni, R.R.; Patki, P.S.; Jog, V.P., Gandage, S.G. and Patwardhan, B.
Treatment of osteoarthritis with a herbomineral formulation: a double-blind, placebo-controlled, cross-over study. *J. Ethnopharmacology* **33**(1-2) p.91-95 (1991)

59. Kulkarni, S.K. and George, B.
GABA_A receptor modulation by herbal preparation. *Int. Sem. on Recent Trends in Pharmaceutical Sci.*, Ootacamund, Feb., 1995
60. Kulkarni, S.K., Sharma, A., Verma, A. and Ticku, M.K.
GABA receptor mediated anticonvulsant action of *Withania somnifera* root extract. *Indian Drugs* **30**(7) p.305-312 (1993)
61. Kulkarni, S.R. and Tipnis, H.P.
Studies in decontamination of some crude drugs by gamma radiation (Part V) (Vasaka & Ashwagandha). *Indian Drugs* **29**(9) p.399-304 (1992)
62. Kumar, Sushil *et.al.*
Medicinal plants in skin care. Central Institute of Med. & Arom. Plants, India. 1994
63. Linder, Sharon
Withania somnifera. *Aust. J. Med. Herbalism* **8**(3) p.78-82 (1996)
64. Lohar, D.R., Chaturvedi, D. and Varma, P.N.
Mineral elements of a few medicinally important plants. *Indian Drugs* **29**(6) p.271-273 (1992)
65. Mahrshi, R.P.
Withania somnifera - a new host for *Myrothecium roridum*. *Indian J. Mycology & Plant Pathology* **16**(2) p.199 (1986)
66. Manonmani, S., William, S., Subramanian, S. and Govindasamy, S.
Biochemical evaluation of the antiulcerogenic effect of Cauvery-100 (An Ayurvedic formation) in rats. *J. Ethnopharmacology* **42**(1) p.1-5 (1994)
67. McLeod, D.
The herbal treatment & management of impotence. *Australian J. Medical Herbalism* **5**(2) p.41-44 (1993)
68. Mehta, A.K., Binkley, P., Gandhi, S.S. and Ticku, M.K.
Pharmacological effects of *Withania somnifera* root extract on GABA receptor complex. *Indian J. Medical Research* **94**(B) p.312-315 (1991)
69. Mehta, M. and Sen, D.N.
Effect of different photoperiods & lights of different wave lengths on seed germination of *Withania somnifera* (Linn.) Dunal. *Science & Culture* **56**(7) p.300-301 (1990)
70. Menssen, H.G. and Staesche, K.
Morphology & anatomy of Indian roots of *Withania somnifera*. *Planta Medica* **26**(3) p.269-278 (1974)
71. Menssen, H.G. and Stapel, G.A.
C28-steroid lactone from the roots of *Withania somnifera*. *Planta Medica* **24**(1) p.8-12 (1973)
72. Nadkarni, A.K.
Indian Materia Medica. Popular Book Depot, Bombay 1954
73. Narendranath, K.A., Anuradha, V., Mahalingam, S. and Sanjeeva Rao, I.
Effect of herbal galactagogue (Lactare), a pharmacological and clinical observation. *Med. Surg.* **26**(4) p.19-22 (1986)

74. Nashine, K., Srivastava, D.N. and Sahni, Y.P.
Role of inflammatory mediators in anti-inflammatory activity of *Withania somnifera*. *Indian Veterinary Medical J.* **19**(4) p.286-288 (1995)
75. Nigam, K.B., Patidar, H., Kandalkar, V.S. and Pathan, M.A.
A new, promising, pre-release variety, 'WS 20', of ashvagandha (*Withania somnifera*). *Indian J. Agricultural Sci.* **61**(8) p.581-582 (1991)
76. Nigam, K.B., Rawat, G.S. and Prasad, B.
Effect of methods of sowing, plant density and fertility level on *Withania somnifera*. *South Indian Horticulture* **32**(6) p.356-359 (1984)
77. Ozguven, M., Sener, B., KIRICI, S. and Kusmenoglu, S.
Drug yields and withanolide contents of *Withania somnifera* Dunal cultivated in Turkiye. *J. Faculty of Pharmacy, Gazi* **8**(2) p.89-100 (1991)
78. Ozguven, M. and Sener, B.
Drug yield withanolide contents of *Withania somnifera* (L.) Dunal cultivated in Turkey. *Acta-Horticulturae* (306) p.219-228 (1992)
79. Pachori, M., Rathee, P.S. and Mishra, S.N.
The seed oil *Withania somnifera* W.S.20 variety. *Asian J. Chemistry* **6**(2) p.442-444 (1994)
80. Pal, M., Misha, M. and Bhandari, H.C.S.
Effect of auxin on rooting branch cutting of *Withania somnifera*. *Indian J. Forestry* **17**(1) p.58-60 (1994)
81. Panda, M.
The effect of Laksha Guggulu in the clinical management of fractures. *J. Research Ayurveda & Siddha* **11**(1-4) p.7-19 (1990)
82. Parikh, M.D., Pradhan, P.V., Shah, L.P. and Bagadia, V.N.
Evaluation of indigenous psychotropic drugs-a preliminary study. *J. Res. Ayur. Siddha* **5**(1-4) p.12-17 (1984)
83. Patidar, H., Kandalkar, V.S. and Nigam, S.
Estimation of leaf area in *Withania somnifera*. *Indian J. Agricultural Sci.* **60**(4) p.263-264 (1990)
84. Patidar, H., Nigam, K.B. and Kandalakar, V.S.
Selection for high dry root yield of Ashvagandha. *Current Research University of Agricultural Sci. Bangalore* **22**(3-5) p.50 (1993)
85. Patwardhan, B.S., Panse, G.T. and Kulkarni, P.H.
Ashwagandha (*Withania somnifera*) - a review. *J. National Interated Medical Association* **30**(6) p.7-10 (1988)
86. Peshney, N.L. and Moghe, P.C.
Inhibition of tobacco mosaic virus of chilli by plant extract. Bot. pesticides in integrated pest management: *Proc. Nat. Sym. held in 1990*. p.460
87. Praveenkumar, V., Kuttan, R. and Kuttan, G.
Chemoprotective action of Rasayanas against Cyclophosphamidetoxicity. *Tumori* **80**(4) p.306-308 (1994)
88. Rai, N.P. and Chaturvedi, G.N.
A medicinal study on Ashvagandha (*Withania somnifera* Dunal, Solanaceae.). *Nagarjun* **24**(9) p.199-201 (1981)

89. Ramarao, P., Rao, K.T., Srivastava, R.S. and Ghosal, S.
Effects of glycowithanolides from *Withania somnifera* on morphine-induced inhibition of intestinal motility & tolerance of analgesia in mice. *Phytotherapy Research* 9(1) p.66-68 (1995)
90. Roja, G., Heble, M.R. and Sipahimalani, A.T.
Tissue cultures of *Withania somnifera*: Morphogenesis and withanolide synthesis. *Phytotherapy Research* 5(4) p.185-187 (1991)
91. Roy, A.S., Acharya, S.B. De, A.K. and Debnath, P.K.
Mountain medicine: effect of *Withania somnifera* on the changes of psychophysiological status of trainee mountaineers by altitude gain. *International Seminar-Traditional Medicine*, Calcutta 7-9 Nov.1992 p.161
92. Roy, U., Mukhopadhyay, S., Poddar, M.K. and Mukherjee, B.P.
Evaluation of antistress activity of *Withania somnifera* and *Ocimum sanctum* with special reference to stress induced stomach ulcer in albino rats. *International Seminar-Traditional Medicine*, Calcutta, 7-9 Nov.1992, p.141
93. Sadique, J., Al-Rqobah, W.A., Bughaith, M.F. and El-GIndy, A.R.
The bio-activity of certain medicinal plants on the stabilization of RBC membrane system. *Fitoterapia* 60(6) p.525-532 (1989)
94. Saeed, V.A., Husain, S.A. and Husain, S.S.
Spindle anomalies in microsporogenesis in a population of *Withania somnifera* (L.) Dunal from Karachi. *Pakistan J.Scientific & Indus.Res.* 32(4) p.247-249 (1989)
95. Sahni, Y.P. and Srivasava, D.N.
Role of inflammatory mediators in anti-inflammatory activity of *Withania somnifera* on chronic inflammatory reaction. *Indian Veterinary Medical J.* 19(2) p.150-153 (1995)
96. Sahni, Y.P. and Srivastava, D.N.
Anti-inflammatory and anti-ulcerogenic activity of *Withania somnifera*. *Update Ayurveda -94*, Bombay, India p.76 (1994)
97. Sahni, Y.P. and Srivastava, D.N.
Withania somnifera: an indigeneous anti-ulcerogenic drug. *Indian J.Indigenous Medicines* 10(1) p.53-56 (1993)
98. Sahu, T.R.
Two new records from Bundelkhand region. *Geobios New Rep.* 2(2) p.158-159 (1983)
99. Sattar, A., Ghanai, M.Y. and Khan, S.H.
Fatty acids of indigenous resources for possible industrial applications Part XV. *Pakistan J.Sci. & Indust.Res.* 31(2) p.139-141 (1988)
100. Sethi, P.D., Ravindran, P.C., Sharma, K.B. and Subramanian, S.S.
Antibacterial activity of some C28 steroidal lactones. *Indian J.Pharmacy* 36(5) p.122-123 (1974)
101. Sharada, A.C., Emerson Soloman, F. and Uma Devi, P.
Toxicity of *Withania somnifera* root extract in rats & mice. *Int.J.Pharmacognosy* 31(3) p.205-212 (1993)

102. Sharada, A.C., Solomon, F.E., Uma Devi, P.M., Srinivasan, K.K. and Udupa, N.
Withaferin A and plumbaagin: Isolation and acute toxicity studies. *Amala Research Bulletin* 13(August) p.20-23 (1993)
103. Shareef, M.A.
Management of cervical spondylosis through herbal drugs *Withania somnifera* Dunal & *Smilax China* Linn. A preliminary clinical study. *Medicinal Plants: New Vistas of Research* p.97-101 (1993)
104. Sharma, K. and Dandiya, P.C.
Withania somnifera Dunal-present status. *Indian Drugs* 29(6) p.247-253 (1992)
105. Shaw, B.P. and Maithy, L.N.
A comparative study of certain ayurvedic drugs of amlapitta. *Nagarjun* 26(4) p.73-75 (1982)
106. Sholapurkar, M.L.
Lactate-for improving lactation. *Indian Pract.* 39(11) p.1023-1026 (1986)
107. Singh, N., Singh, S.P., Nath, R., Singh, D.R., Gupta, M.L., Kohli, R.P. and Bhargava, K.P.
Prevention of urethane-induced lung adenomas by *Withania somnifera* (L.) Dunal in albino mice. *Int. J. Crude Drug Res.* 24(2) p.90-100 (1986)
108. Singh, R.H., Nath, S.K. and Behere, P.B.
Depressive illness a therapeutic evaluation with herbal drugs. *J. Research in Ayurveda & Siddha* 11(1-4) p.1-6 (1990)
109. Stoller, E.W., Stohs, S.J., El Oley, M.M., Poli Chen Yu and Tarng, C.S.
Fatty acid composition of lipid of *Corchorus*, *Yucca*, *Dioscorea*, *Withania* and *Rivea* tissue cultures. *Lloydia* 37(2) p.309-312 (1974)
110. Sudhir, S., Budhiraja, R.D., Miglani, G.P., Arora, B., Gupta, L.C. and Garg, K.N.
Pharmacological studies on leaves of *Withania somnifera*. *Planta-Medica* (1) p.61-63 (1986)
111. Sukh Dev
Ayurveda & modern drug development. *International Seminar-Traditional Medicine*, Calcutta, 7-9 Feb. 1992 p.44-45
112. Twajj, H.A.A., Elisha, E.E., Elisha, E. and Khalid, R.M.
Analgesic studies on some Iraqi medicinal plants. Part II. *International J. Crude Drug Research* 27(2) p.109-112 (1989)
113. Uma Devi, P., Sharada, A.C. and Solomon, F.E.
Anti-cancer potential of Ashwagandha roots. *Update Ayurveda-94*, Bombay, India-24-26th Feb. p.56 (1994)
114. Uma Devi, P., Sharada, A.C. and Solomon, F.E.
Antitumor and radiosensitizing effects of *Withania somnifera* on a transplantable mouse tumor, Sarcoma-180. *Indian J. Exp. Biology* 31(7) p.607-611 (1993)
115. Uma Devi, P., Sharda, A.C., Solomon, F.E. and Kamath, M.S.
In vivo growth inhibitory effect of *Withania somnifera* on a transplantable mouse tumor, Sarcoma 180. *Indian J. Exp. Biology* 30(3) p.169-172 (1992)
116. Vaidya, K. and Kulkarni, P.H.
A study of an Ayurvedic formula viz. Jivak. *Deerghayu International* 7(1) p.20 (1991)

117. Velde, V.V. and Lavie, D.
New withanolides of biogenetic interest from *Withania somnifera*. *Phytochemistry* **20**(6) p.1359-1364 (1981)
118. Vishnoi, A., Babbar, S.B. and Gupta, S.C.
Induction of androgenesis in anther cultures of *Withania somnifera*. *Zeitschrift für Pflanzenphysiologie* **94**(2) p.169-171 (1979)
119. Watt, J.M., Breyes-Brandwijk, M.G.
The Medicinal and Poisonous plants of Southern & Eastern Africa. E & S Livingstone Ltd., London. 1962
120. Yidya Prabhu, M., Rao, A. and Karanth, K.S.
Neuropharmacological activity of *Withania somnifera*. *Fitoterapia* **61**(3) p.237-240 (1990)
121. Yu, P.L.C., El Oley M.M. and Stohs, S.J.
A phytochemical investigation of *Withania somnifera* tissue cultures. *Lloydia* **37**(4) p.593-597 (1974)
122. Zaidi, Z.B., Gupta, V.P., Samad, A. and Naqvi, A.Q.
Inhibition of spinach mosaic virus by extracts of some medicinal plants. *Curr.Sci.* **57**(3) p.151-152 (1988)
123. Zaim, M. and Samad, A.
Association of phytoplasmas with a witches-broom disease of *Withania somnifera* (L.) Dunal in India. *Plant Science* **109**(2) p.225-229 (1995)