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Phytochemical, Pharmacological and Beneficial Effects of *Withania coagulans* Dunal. (Paneer Doda): A Review

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ABSTRACT

There are numerous medicinal plants given in Ayurvedic texts, particularly in Nighantus. One of them is Rushyagandha which has been applied for the management of different diseases. Plant based medicines have distributed much awareness in today's society due to their no. of well proven therapeutic effects and lack of side effects which has provoked the human to go back towards nature for safer herbal remedies. In northern India, its fruits are applicable in the treatment of Prameha (Diabetes). This plant of *Withania coagulans* has the property of coagulating milk and has been used for preparing vegetable rennet ferment for making cheese. The plant, *Withania coagulans* Dunal is one of them which is used to treat different diseases and used in folk medicines. It has been shown to exert hypoglycemic, hypolipidemic, free radical scavenging, cardiovascular, central nervous system depressant, hepatoprotective, anti-inflammatory, wound healing, antitumor, immuno-suppressive, cytotoxic, antifungal and antibacterial properties. The twigs are chewed for cleaning of teeth and the smokes of the plant are inhaled for relief in toothache. The more numbers of phytochemicals have been separated from Withania coagulans which are responsible for different pharmacological action of this plant. The present article aims in projecting a detailed review of the plant *Withania coagulans* about its morphology, chemical constituents and pharmacological properties. It has also included therapeutic effects of the whole plant and its extracts and isolated withanolides.

INTRODUCTION

Ayurveda is the science of life. The basic aim or objective of Ayurveda is maintenance or balance of health and diagnosis &treatment of various diseases. The plants and herbs are the key source of medicine in Ayurveda for treatment and prevention of diseases, disorders and maintenance of healthy life. The plants are used in medicine since antiquity. Much of the medicinal plants are documented in the ancient ayurvedic classics and these plants are still nowadays used successfully, randomly to treat different ailments, diseases. One of those plants which is used to treat various diseases is *Withania Coagulans Dungal.*

Rishyagandha is mentioned by *Acharya Charaka In Bruhaniya Mahakashaya*[1], *and* in *madhura skanda*[2]. In *Bruhaniya Mahakashaya Chakrapani* – the one of the commentator of *Charaka Samhita* commented *on Rushyagandha* as *Rushya Jangalakaha* i.e. the wild variety.

The term *Rushyagandha* commented as *Rushya Jangulika* denotes the wild variety, types of *Ashwagandha* or likewise drugs. The drug *Ashwagandha* comes and belongs from the *Withania* species. In India, twice species of the genus *Withania* are found[3]. *Withania somnifera* which is known and identified by the name of *Ashwagandha* and *Withania coagulus* called as *paneer dodi* in Hindi language and as Indian rennet in English language. Both the species closely resemble each other. Though withanolides are the principle compound found in both species, there are some withanolides specific to each of them.

Antihyperglycemic leads from *Withania coagulans* have been identified[4]. *Withania somnifera* has been application in antioxidant, adaptogen, aphrodisiac, liver tonic, anti-inflammatory agent and most recently as an antibacterial, antihyperglycemic, hypolipidaemic, and antitumoural as well as to treat ulcers and senile dementia[5]. Hepatoprotective[6], anti-inflammatory[7], antihyperglycemic[8], hypolipidaemic[9] free radical scavenging activity[10], antimicrobial[11], cardiovascular[12], central nervous system depressant[13], immunomodulatory[14], antitumour[15], cytotoxic activities[16] have been studied in *Withania coagulans*. Withania had the therapeutic values, significance overall. The plant is native of the Asia temperate and Asia tropical regions[17]. A survey of literature has shown that in various traditional systems of medicine, the plant has been recommended for the treatment of various disorders.

Diabetes currently is a major health problem for the people of the whole world. Diabetes is a chronic disorder of carbohydrate, fat and protein metabolism characterised by elevation of both fasting and post-paradinal blood sugar levels. The synthetic oral hypoglycaemic agents can give serious side effects. In addition, they are not considered to be safe for use during pregnancy. Furthermore, after the recommendation made by WHO on diabetes mellitus investigation on hypoglycaemic agents from medicinal plants have become more important[18-21]. Coagulans dunal is very well known for its ethnopharmacological activities.

In Punjab, the fruits of *W. coagulans* are used as the source of coagulating enzyme for clotting the milk which is called 'paneer'. Buffalo or sheep milk is warmed to about 100 degree farrate and crushed berries of plant, tied in cloth, are dipped in it. The milk takes 30-40 minutes to curdle. The plant is known as 'the cheesemaker' or 'vegetable rennet' because fruits and leaves of the plant are used as a coagulant. The milk coagulating property of the fruit is attributed to the pulp and husk berries which possess an enzyme which has a milk coagulating activity. In some parts of Pak-Indian sub-continent, the berries are used as a blood purifier. The twigs are chewed for cleaning of the teeth and the smoke of the plant is inhaled for relief in toothache[22-25].

Botanical analysis of *Withania coagulans*:

Botanical Name : *Withania coagulans* Dunal

Family : Solanaceae

Subfamily : Solanoideae

Tribe : Physaleae

Subtribe : Withaninae

Sanskrit Name : Rishyagandha[26, 27]

Hindi Name : Punir, Punir bandh, Akri, Binputakah, Paneer doda

English Name : Indian Cheesemaker, Indian Rennet, Vegetable Rennet

Trade Name : Paneer dodi, Panner, doda, Panir bed, Paneer dhodi.

Kingdom : Plantae.

Clade : Tracheophytes

Clade : Angiosperms

Clade : Eudicots

Clade : Asterids

Order : solanales

Genus : Withania

Species : *W. coagulans*.

Binomial name : *Withania coagulans* (Stocks) dunal.

Synonym : *Punneria coagulans* stocks[28].

Vernacular Name of *Withania coagulans*: The plant of *Withania coagulans* is known by different names in different local areas languages such as;

Urdu - Hab kaknaj

Bengal - Asvagandha

Bombay - Kaknaj

Gwalior - Asgandha

Punjab - Khamjaria, Khamjira, Panir

Sindhi - Punirjafota, Punirband

Persian - Kaknajehindi, Punirbad

Arabic - Javzulmizaja, Kaknajehindi

Canares - Asvagandhi

Telugu - Panneru-gadda

MORPHOLOGICAL CHARACTERS:

A rigid grey- tomentose undershrub 0.3-0.9 m. high, branches terete, clothed with dense grey or yellowish white tomentum.

- **Leaves:** 2.5-5.7 by 1-2.2 cm., lanceolate-oblong, obtuse, entire, clothed with a persistent not easily detachable greyish tomentum, of a uniform colour on both sides, thick, more or less rugose, base acute, running down into an often obscure petiole; petiole 6 mm. long but often indistinct.

- **Flowers:** Dioecious, in axillary clusters; pedicles 0-6mm. long, deflexed, slender. Calyx 6 mm. long, campanulate, clothed with fine stellate grey tomentum; teeth triangular, 2.5 mm. long. Corolla 8 mm. long, stellately mealy outside, divided about 1/3 the way down; lobes ovate-oblong, subacute. Male flowers: Stamens about level with the top of the corolla- tube; filaments 2 mm. long, glabrous; anthers 3-4 mm. long. Ovary ovoid, without style or stigma. Female flowers: Stamens scarcely reaching ½ way up the corolla-tube; filaments about 0.85 mm. long; anthers smaller than in the male flowers, sterile. Ovary ovoid, glabrous; style glabrous; stigma mushroom- shaped, 2-lamellate.

- **Fruits:** Berry 6-8 mm. diam., globose, smooth, closely girt by the enlarged membranous calyx which is scurfy pubescent outside.

- **Seeds**: 2.5-3 mm. diam., somewhat ear-shaped, glabrous. Seeds: 2.5-3mm diam., dark brown, ear-shaped, glabrous;

- **Flowering period:** from January to April and berries ripen during January to May. The natural regeneration is from seed[29].

In traditional medicine, the Panchanga means all parts, flowers, fruits are used. It shows significant lowering of blood sugars, serum cholesterol, serum lipid peroxide (LPO). Nowadays its flowers and fruits are commonly used in the treatment of diabetes as a traditional medicine.

CHEMICAL COMPOSITION:

Withaferin A is the most important of the withanolides isolated so long. It has good antibiotic and anti-tumour activities. Withaferin A in concentration of 10µml. inhibited the growth of various gram-positive bacteria, acid fast bacilli, aerobic bacilli and pathogenic fungi. Withaferin A has marked tumor inhibitory property when studied in vitro against cells derived from human carcinoma of nasopharynx (KB). It also acts as mitotic poison arresting the division of cultured human larynx carcinoma cells at metaphase. The studies also showed growth inhibitory and radiosensitizing effects in vivo on mouse Ehrlich ascites carcinoma. It also caused mitotic arrest in embryonal chicken fibroblast cell[30]. Withaferin A inhibits angiogenesis (Mohan et al., 2002)[31].

The berries contain the milk-coagulating enzyme, two esterases, free amino acids, fatty oil, essential oil and alkaloids. The amino acids present are proline, hydroxyproline, valine, tyrosine, aspartic acid, glycine asparagine, cysteine and glutamic acid. Fourteen alkaloidal fractions have been isolated from the alcoholic extract of the fruits. The seeds on petroleum ether extraction, give a yellow fatty oil and unsaponifiable matter. Fatty acid compositions are oleic, linoleic, palmitic, stearic and arachidonic acid. The unsaponifiable matter consists of triacontain, three sterols including dihydro stigmasterol and β-sitosterol. The defatted meal from the seeds contains free sugar consisting of D-galactose and D-arabinose and traces of maltose. The leaves contain four steroidal lactones called Withanolides, viz Withaferin-A, 5, 20α(R)- dihydroxy-6α,7α-epoxy-1-oxo-(5α)-with a-2,24-dienolide and two minor withanolides, of which one is probably 5α, 17α-dihydroxy-1-oxo-6α, 7α-epoxy-22R-witha-2,24-dienolide (the so called withanone)[30].

THERAPEUTIC SIGNIFICANCE

It has antimicrobial, anthelmintic, antifungal, Hepatoprotective, hypoglycaemic, hypolipidaemic, cardiovascular, free radical scavenging, anti-inflammatory, antitumor, immunosuppressive, depressant property[4]. In Northern India, traditional healers use dry fruits for the treatment of Diabetes mellitus. Round capsular fruit and the leaves have the peculiar property of coagulating or curdling milk; a little portion is rubbed with a small portion of water or milk and is added to the milk to be coagulate. Dried capsules also retain the coagulating property in an equal degree. The active principle named “withanin” residing in

the numerous small seeds contained within the capsules is a ferment closely allied to the animal rennet[32].

The dried fruits, sold as Punir-ja- fota in Sind, are employed in dyspepsia and flatulent colic, and other intestinal affections. They are prescribed in infusion, either alone or conjoined with the leaves and twigs of Rhazya stricta, an excellent bitter tonic. Honigberger says that the bitter leaves are given as febrifuge by the Luhanees. In Bombay, the berries have a reputation as blood purifiers. They are used as an emetic. In Las Bella, the fruit is pounded and used as a cure for colic; the wood is used for cleaning the teeth. In the Ormera Hills, the smoke is applied to aching teeth 'to destroy the worm' (Hughes Buller). The twigs are chewed for cleaning teeth, and the smokes of the plant are inhaled for relief in toothache.

The fruits are sweet; applied to wounds; used in asthma, biliousness strangury. The seeds are diuretic; useful in lumbago, opthalmia; lessen the inflammation of piles. The ripe fruits are supposed to possess anodyne or sedative properties. They are alterative, diuretic and believed to be useful in chronic liver complaints[29&30].

EXPERIMENTAL STUDIES DONE ON *WITHANIA COAGULAS* DUNAL:

Antihyperglycaemic Activity:

The drug *Withania coagulans* exhibited hypoglycaemic activity which is an effective and very safe alternative treatment for diabetes mellitus (Budhiraja et al 1977)[33]. Hypoglycemic activity of *Withania coagulans* was exhibited in streptozotocin induced rats (Hemalatha et al 2004)[34]. Application base improvements in symptoms and signs were observed in rats and euglycemia was attained in diabetes mellitus type 2 (Jaiswal et al 2009)[35]. A withanolide, named as coagulanolide isolated from Withania coagulans fruits has antihyperglycemic activity in rats (Maurya et al 2008)[36]. The median effective dose of isolated coagulanolide from fruits of *Withania coagulans* was determined about 25 mg/kg in streptozotocin-induced diabetic rats, which is comparable with the standard antidiabetic drug metformin (Maurya et al 2008)[36]. The nearly total4- week treatment with *Withania coagulans* dried fruit extract significantly reversed hyperglycaemia in streptozotocin-induced diabetic rats that was comparable to glipizide[37].

EFFECTS ON CIRCULATORY OR CARDIOVASCULAR SYSTEM :

A steroidal lactone, Withanolide Separated from the aqueous extract of fruits of *Withania coagulans*, has cardiovascular effect. A new withanolide, with a special chemical structure same as the aglycones of the cardiac glycoside, separated from the fruits of *Withania coagulans*. This withanolide create a moderate fall of blood pressure in dogs which has blocked by atropine and not mepyramine or propranolol. In rabbits Langendorff preparation and ECG studies, produced myocardial depressant effects but in perfused frogs hearts it causes mild positive inotropic i.e. increase in force of contraction heart and positive chronotropic effects i.e. increase in the heart rate (Budhiraja et al 1983)[44].

ANTI – INFLAMMATORY ACTIVITY :

The alcoholic extract of Withania coagulans be seen significant anti-inflammatory effect in acute inflammation induced with egg albumin (Budhiraja et al 1977)[33]. A withanolide from *Withania coagulans* showed significant anti-inflammatory activities in acute inflammation (Budhiraja et al 1984) [39]. The hydroalcoholic extract of *Withania coagulans* fruits showed significant anti-inflammatory activity in carragenin induced rat paw oedema model also (Rajurkar et al 2001)[40].

IMMUNOSUPPRESSIVE EFFECTS :

Withaferin A and withanolide E were disclosed to have special immunosuppressive effects on human B and T lymphocytes as well as on mice thymocytes (Shohat et al 1978)[45]. A well-known withanolide, coagulin-H, was analyse for its effect on different cellular functions and actions related to immune responses including lymphocyte proliferation, interleukin-2 (IL-2) cytokine expression. These results were compared with prednisolone. Coagulin-H was observed to have a powerful inhibitory effect on lymphocyte proliferation and the Th-1 cytokine production. The inhibition of the phytohaemagglutinin (PHA) activated T-cell proliferation by coagulin-H (Mesaik et al 2006)[46].

ANTIHYPERLIPIDEMIC ACTIVITY ;

The aqueous extract of *Withania coagulans* fruits in higher fatty diet influenced hyperlipidemic rats, usefully reduced elevated serum cholesterol, triglycerides, lipoprotein and the LPO levels. The hypolipidemic effect of *Withania coagulans* fruits were found to be

comparable with ayurvedic products holding *Commiphora Mukul* (Hemalatha et al 2006)[38]. The coagulanolide separated from fruits of *Withania coagulans* has antidyslipidemic action on mice (Maurya et al 2008)[36]. The hydroalcoholic extract of *Withania coagulans* dried fruits was very effective and comparable to atorvastatin in controlling the high cholesterol diet-induced hyperlipidaemia in rats.

ANTIFUNGAL AND ANTIBACTERIAL EFFECTS:

The ethereal oil obtained by steam distillation of the petroleum ether extract of the fruits was very active against *Micrococcus pyogenes* var. aureus and *Vibrio cholerae* (Gaind & Budhiraja 1967)[41]. The volatile oil from the fruits of *Withania coagulans* showed antibacterial activity against *Staphylococcus aureus* and *Vibrio cholerae* (Khan et al 1993 Choudhary et al 1995)[42, 43]. Two withanolides (14,15β-epoxywithanolide I [(20S,22R) 17β,20β-dihydroxy -14β, 15β-epoxy-1-oxo-witha3,5,24-trienolide] and 17β- hy-droxywithanolide K (20S,22R) 14α,17β,20β-trihydroxy- 1-oxo-witha-2,5,24- trien-olide]) have been separated from the *Withania coagulans* . The second compound was found to be active against a number of potentially pathogenic fungi (Choudhary et al 1995). The antifungal activity of the crude extract, 17β-hydroxy withanoloied k and withanolide F were tested against nine highly pathogenic fungi. These compounds also showed activity against gram positive bacteria (Atta-ur-Rahman and Choudhary 1998).

➢ OTHER ACTIVITIES OF *WITHANIA COAGULAS* :

i. By using the aqueous extract of *Withania coagulans* fruits in experimental rats have a diuretic potential. Withanolides from *Withania coagulans* are more polar in nature compared to the other Withania species. The diuretic effects may be related with the existence of the active principles of polar nature where withanolides lead role of chemical protagonist of this activity. Dabheliya et al (2010)[52] investigation supports using *Withania coagulans* as the diuretic agent in traditional folklore medicine.

ii. *Withania coagulans* has wound healing activities in streptozotocin-induced diabetic rats. The hydroalcoholic fraction (i.e. Solution in which solvent is a mixture of alcohol and water) of the methanolic extract (standardized by Withaferin A) of *Withania coagulans* in both topical and oral form showed an application increase in the rate of wound contraction. The Withaferin-A is responsible for significant increase in the collagen levels, protein, DNA, SOD, CAT and decreased level of hexosamine (Prasad et al 2010)[48].

iii. The extract of *Withania coagulans* have hypotensive, respiratory stimulant and muscular relaxant activity in experimental animals Siddiqui et al (1963)[53].

iv. The aqueous extract of *Withania coagulans* also indicates free radical scavenging activity in an in vitro system using DPPH (Budhiraja et al 1986)[47]. (Hemalatha et al 2004)[34]. Aqueous extract of fruits of *Withania coagulans* have antioxidant potential against several diseases and disorders such as ageing, atherosclerosis etc. which caused due to ROS. (Mathur et al. 2011)[49].

v. However, The hepatoprotective effect of 3F-hydroxy-2, 3 dihydro-withanolide F obtained from fruit of *Withania coagulans* was studied and observed against the CCl_4 induced hepatotoxicity in adult albino rats. (Budhiraja et al 1986)[47]observed that the Hepatoprotective effect of withanolide F was more active than hydrocortisone.

vi. The essential oil obtained by steam distillation of the petroleum ether extract of the fruits of *Withania coagulans* has given anthelmintic activity (Gaind and Budhiraja 1967)[41]. The aerial parts of *Withania coagulans* have anthelmintic activity in ruminants (Jabbar et al 2006)[50]. Also Khare reported an anthelmintic activity for *Withania coagulans* (Khare et al 2007)[51].

CONCLUSION

With all above references, we can say that the various part i.e. berries, leaves, root etc. of *Withania coagulans* have many variety of biological activity. Withanolides are steroidal lactones having significant pharmacological activities and applications. It is a very important medicinal herb as larger number of phytochemicals (esterases, free amino acids, fatty oil, an essential oil, alkaloids and withanolides) has been separated from this plant. In numerous studies, it has been seen that the *Withania coagulans* possess several medicinal properties such as Hepatoprotective, anti-inflammatory, antihyperglycemic, free radical scavenging, hypolipidaemic, antimicrobial, cardiovascular, central nervous system depressant, immunomodulating, antitumour and cytotoxic activities. In future further study on this plant to elucidate its effect on other diseases, disorders and mechanism of action in depth is need of hour. In the coming advanced era, it could be considered as noble ayurvedic drug for the treatment of various diseases or ailments.

REFERENCES

1. Bramhananda Tripathi, Charaka Samhita Purvardha, Vimansthanam 8/139, p. 76, Chaukhamba Bharti Academy, Varanasi, 2006.
2. Bramhananda Tripathi, Charaka Samhita Purvardha, Sutrasthanam 4/9, p. 779, Chaukhamba Bharti Academy, Varanasi, 2006.
3. Chadha YR. The Wealth of India, Raw Materials, vol. 10. New Delhi: CSIR, 1976.
4. Maurya R et al. Coagulanolide, a withanolide from Withania coagulans fruits and antihyperglycemic activity. Bioorg Med Chem Lett 2008; 18: 6534–6537.
5. Mirjalili MH et al. Steroidal lactones from Withania somnifera, an ancient plant for novel medicine. Molecules 2009; 14: 2373–2393.
6. Budhiraja RD et al. Protective effect of 3-b-hydroxy-2,3 dihydro withanolide F against CCl4 induced hepatotoxicity. Planta Med 1986; 28–29.
7. Budhiraja RD et al. Anti-inflammatory activity of 3-b-hydroxy- 2,3-dihydro withanolide F. Planta Med 1984; 50: 134–136.
8. Budhiraja RD, Sudhir S. Review of biological activity of withanolides. J Sci Ind Res 1987; 46: 488–491.
9. Hemalatha S et al. Hypolipidemic activity of aqueous extract of Withaniacoagulans Dunal in Albino rats. Phytother Res 2006; 20: 614–617.
10. Hemalatha S etal. Hypoglycemic activity of Withania coagulans Dunal in streptozotocin induced diabetic rats. J Ethnopharmacol 2004; 93: 261–264.
11. Choudhary MI et al. Antifungal steroidal lactones from Withania coagulans. Phytochemistry 1995; 40: 1243– 1246.
12. Budhiraja RD et al. Cardiovascular effects of a withanolide from Withaniacoagulans Dunal fruits. Indian J Physiol Pharmacol 1983; 27: 129–134.
13. Budhiraja RD, Sudhir S. Review of biological activity of withanolides. J Sci Ind Res 1987; 46: 488–491.
14. Mesaik MA et al. Biological and molecular docking studies on coagulin-H: human IL-2 novel natural inhibitor. Mol Immunol 2006; 43: 1855–1863.
15. Mohan R et al. Withaferin A is a potent inhibitor of angiogenesis. Angiogenesis 2004; 72: 115–122.
16. Fuskova A etal. Novel cytotoxic and antitumor agents. IV. Withaferin A: relation of its structure to the in vitro cytotoxic effects on P388 cells. Neoplasm 1984; 312: 31–36.
17. Kirtikar KR, Basu BD. Indian Medicinal Plants. Dehradune, India: International Book Distributors, 1995.
18. Datta A et al, "Antidiabetic and antihyperlipidemic activity of hydroalcoholic extract of Withania coagulans Dunal dried fruit in experimental rat models". PMC article, 2013; 4(2):99-106.
19. Banshidhar B, Deepmala Y, "Current Researches on Plants Having Antidiabetic Potential". Research and Reviews: Journal of Botanical Sciences, 2013; 2(2):4-17.
20. HG. Vogel et al, "Drug discovery and Evaluation". Pharmacological Assays, Second Edition; 2002: 948.
21. Tripathy KD, "Essentials of pharmacology". 4th edition, New Delhi, Jaypee brother's medical publishers Pvt. Ltd. `1999: 256.
22. Larner, J., 1985. Insulin and oral hypoglycemic drugs; Glucagon. In: Gilman, A.G., Goodman, L.S., Rall, T.W., Murad, F. (Eds.), The Phar- macolgical Bases for Therapeutic, seventh ed. Macmillan, New York, pp. 149–151.
23. Imran M, Khan M, Akhtar R, Ahmed S, Rageeb M. Antidiabetic and hypolipidemic effect of methanol extract of stereospermum colais fruit in streptozotocin induced diabetic rats. Journal of Drug Delivery and Therapeutics, 2016; 6(4):41-47. doi: 10.22270 /jddt.v6i4 .1272.
24. Jhansee M, Alok DK, Shailesh MN, Ashish GK, "Withania Coagulans in Treatment of Diabetics and Some Other Diseases: A Review". Research Journal of Pharmaceutical, Biological and Chemical Sciences, April-June 2013; 4(2):1251.
25. Manivannan R, Shopna R, Antidiabetic activity of Calotropis gigantea white flower extracts in alloxan induced diabetic rats. Journal of Drug Delivery and Therapeutics, 2017; 7(3):106- 111. doi:10.22270/jddt.v7i3.1447.
26. Illustrated Dravyaguna Vijnan, Vol. 5, by Prof. P.V. Sharma, Chaukhamba Bharati Academy, Reprint 2006.

27. Mishra Shaival; 'Studies on Madhumehaharakarma of Rishyagandha (Withania coagulans) and Amalaki (Emblica officinale).' [Ph.D. research work in department of Dravyaguna, Faculty of Ayurveda, IMS, BHU, 2008.]
28. *"The Plant List: A Working List of All Plant Species". Retrieved 3 February 2015.*
29. Kirtikar K.R. and Basu· B.D., Indian Medicinal Plants, Text VoI.-III, 2nd Edi., International Book Distributors, Dehra Dun, Uttranchal, India.
30. The Wealth of India; Raw Materials Vol-X, CSIR New Delhi, Reprinted- 2009, Page no. 580-585.
31. Mohan R., Hammers H.J., Bargagna-Mohan, P., Withaferin A is a potent inhibitors of angiogenesis. Angiogenesis, 2004, 7:115-22.
32.Nadkarni K.M., Indian Materia Medica, Revised and enlarged by Nadkarni A.K., Vol.- I, Popular Prakashan Pvt. Ltd. Bombay-34, Reprint- 2002, Page-1291.
33. Budhiraja RD, Sudhir S, Garga KN (1977) Pharmacological investigations on fruits of Withania coagulans Dunal. Planta Medica 32: 154-57
34. S. Hemlatha, A.K. Wahi, P.N. Singh, J.P.N. Chansouria; Hypoglycemic activity of Withania coagulans Dunal in streptozotocine induced diabetic rats, Journal of Ethnopharmacology 93 (2004) 261-264.
35. Jaiswal D., Rai P.K., Watal G., Antidiabetic effect of Withania coagulans in experimental rats. Indian Journal of Clinical Biochemistry, 2009/24 (1) 88-93.
36. Maurya R., Akanksha, Jayendra, Singh A.B. Srivastava A.K., Coagulanoide, a withanolide from Withania coagulans fruits and antihyperglycemic activity, 2008, Bioorganic and Medicinal chemistry letters, 18, 6534.
37. Ankur Datta, Chiranjib Bagchi, Saibal das, Achintya Mitra, Anuradha Depati, Santanu Kumar Tripathi. Antidiabetic and antihyperlipidemic activity of hydroalcoholic extract of Withania coagulans Dunal. Dried fruit in experimental rat model. Journal of Ayurveda and Integrative medicine, April-June 2013; vol.-4, issue-2, page: 99-106.
38. S. Hemlatha, A.K. Wahi, P.N. Singh, J.P.N. Chansouria; Hypolipidemic activity of aqueous extract of Withania coagulans Dunal in albino rats, Phytotherapy Research, volume 20, issue7, (2006) p. 614 – 617.
39. Budhiraja RD, Sudhir S, Garg KN, Arora BC (1984) Anti-inflammatory activity of 3 β-Hydroxy-2, 3-dihydro-withanolide F. Planta Medica 50 (2): 134-136
40. Rajurkar, S.M., Thakre, P.N., Waddukar, S.G., Phytochemical and Pharmacological screening of W. coagulans berries as anti-inflammatory. 53 IPC 2001. New Delhi, Dec. Sci. Abst. CP 38. P. no. 215.
41. Gaind & Budhiraja, Antibacterial and anthelmintic activity of Withania coagulans Dunal. Indian J. Pharm., 1967, 29, 185.
42. Khan MTJ, M Ashrof, S. Tehniyat, MK Bukhtair, S. Ashraf and W Ahmad, Antibacterial activity of Withania coagulans. Fitoterapia, 64(4), 367-370 (1993).
43. Choudhary MI, Dur-e-Shahwar, Z Parveen, A Jabbar, I Ali and Atta-ur-Rahman, Antifungal steroidal lactones from Withania coagulans, Phytochemistry, 40(4), 1243-1246 (1995).
44. Budhiraja RD, Sudhir S, Garg KN, Cardiovascular effects of a withanolide from Withania coagulans Dunal fruits. 1983 Indian J. Physiol. Pharmacol. 27(2), 129-134.
45. Shohat B, Kirson I, Lavie D. 'Immunosuppressive activity of two plant steroidal lactones withaferin A and withanolide E'. Biomedicine. 1978, 28:18–24
46. Mesaik MA, Haq Zu, Muradb S, Ismail Z, Abdullah NR, Gill HK, Atta-ur-Rahman, Yousaf M, Siddiqui RA, Ahmade A, Choudhary MI 'Biological and molecular docking studies on coagulin-H, Human IL-2 novel natural inhibitor.' MOL IMMUNOL 2006, 43:1855–1863
47. Budhiraja, R.D., Sudhir, S., Garg, K.N., Arora, B., 1986. Protective effect of 3beta-hydroxy-2,3 dihydro withanolide F against CCl4 induced hepatotoxicity. Planta Medica 1, 28-29.
48. Prasad S.K., Kumar R., Patel D.K., Hemlatha S., Wound healing activity of *Withania coagulans* in streptozotocine induced diabetic rats. Pharm. Biol. 2010 Dec, 48 (12): 1397-404.
49. Mathur D, Agrawal RC and Shrivastava V (2011) Phytochemical Screening and Determination of Antioxidant Potential of Fruits Extracts of *Withania coagulans*, RRST-Phytochemistry 3(11): 26-29
50. Jabbar A, Raza MA, Iqbal Z, Khan MN (2006) Ethnopharmacological communication an inventory of the ethnobotanicals used as anthelmintics in the southern Punjab (Pakistan). J. ETHNOPHARMACOL 108:152–154
51. Khare CP (2007) Indian Medicinal Plants. Springer-Verlag, Berlin/Heidelberg

52. Dabheliya J, Khan SA, Joshipura M, Vasoya M, Patel S, Vijaya S (2010) Diuretic potential of Aqueous extract of fruits of *Withania coagulans* Dunal in experimental rats. IJPPS 2: 4
53. Siddiqui HH, Israili AH, Qadry SMJS (1963) Studies on *Withania coagulans* Dunal. (PART I), Planta Medica. 2:145.

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