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A Review on Medicinal Importance of *Withania coagulans*



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ABSTRACT

This article has reviewed *Withania Coagulan's* ethnobotanical attributes. The Ayurveda has emphasized employing the plant *Withania coagulans*, which belongs to the Solanaceae family. This includes many plant components that are used around the world, particularly in India, for the treatment of ailments as well as for various human healing capabilities. The anti-diabetic, diuretic effects, the anti-inflammatory effect, hepatoprotective effect, antibacterial, cardiovascular effect, anticancer, free radical scavenging activity, and central nervous system depressive actions led to the discovery of its therapeutic usage. The current review paper emphasizes the importance of species, taxonomy, chemical composition, phytochemistry, and pharmacological activity in addition to isolated substances indicating antihyperglycemic properties. Future scholars will find this plethora of knowledge to be extremely valuable.



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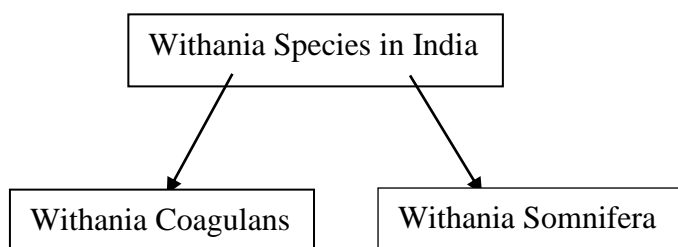
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INTRODUCTION

In order to find new remedial products, plants play an important part. In the past, they have been a rich source of substances including digitalis, cocaine, morphine, and quinine. A variety of medicines have been linked due to pharmacological webbing for natural products.(1) Different societies have come up with their own indigenous medicinal systems. *Withania coagulans* that is also known as the stocks of Puneeria coagulans, distributed throughout the drier corridor of India, vegetable rennet is sometimes referred to as Punir dodi (Hindi), Indian rennet, Indian cheese maker, Panir phool, Panir band, as well as Paneer bandh and Chinese name: Ning gu shui qie.(2) The factory is indigenous to Asia's tropical (Indian Key India, Nepal) and temperate (Western Asia, Afghanistan) areas. According to a survey of the literature indicates that the factory has been proposed in conventional pharmaceutical systems for the treatment of colored diseases. (3) Standing 60-120 cm tall, it is an erect, grayish subshrub. The whole, lanceolate leaves have a permanent layer of gray, cottony tissue covering them on both sides. There flowers are dioecious and bloom in clusters in the axilla. The corolla measures 8 mm in length and has ovoid, elongated subacute lobes. The calyx has a gray cotton membrane covering it and is 6 mm long.(4) Male flowers have 2 mm long, glabrous stamens that are around the length of the corolla tube at its highest point and anthers that are 3 to 4 mm long. The ovary is oval-shaped and scar-free. The anthers of female flowers are smaller than those of male flowers and are sterile. The stamens of female flowers extend halfway into the corolla tube and have a length of around 0.85 mm.(5) The stigma is bilobed and mushroom-shaped, the ovary is oval and glabrous, and the style is also glabrous. The fruit is smooth, spherical, and measures 6 to 8 mm in diameter. (6) The seeds are glabrous, slightly pear-shaped, and have a diameter of 2.5–3 mm. (7,8)



Fig 1. *Withania Coagulans* Fruits



CLASSIFICATION (Taxonomic)

Kingdom: Plantae

Subkingdom: Tracheobionta

Super division: Spermatophyta

Class: Magnolipsida

Order: Solanales

Family: Solanaceae

Genus: Withania

Species: *Withania coagulans* (9)

Phytochemistry

Its uses are notable as it is common in the two plants that traditional healers utilize. A phytochemical examination revealed that the alkaloids, steroids, tannins, saponins, phenolic substances, carbohydrates, proteins, amino acids, and organic acid compounds were among the extracts.(10) Examples of the withanolides (steroid-containing lactones) are the compound coagulin F structure name 27-hydroxy-14,20-epoxy-1-oxo(22R)-witha3,5,24-trioxide) and the coagulin G compound with structure name 17,27-dihydroxy14,20-epoxy-1-oxo(22R). The core granolide the entire *Withania coagulans* plant was used to extract the 17S, 20S, and 22R) - [14,15,17, 20beta -tetrahydroxy-1-oxowitha -2,5,24-trienolide], 20beta -hydroxy-1-oxo-(22R)-witha -2,5,24-trienolide, and with coagulin(2) *Withania coagulan* dunal seed-derived defatted flour has 17.8% free sugars. contains a trace amount quantity of the maltose enzyme and a 1:1 ratio of containing D-galactose and D-arabinose. Studies have

revealed that polysaccharides do not include -galactoside linkages.(11) Seeds of *W. Coagulan* reportedly contain 12-14% fatty oil.(12) The oil was discovered to have a high content of fatty acids like linoleic acid and beta-sitosterol. This combination is said to be the root cause of corn oil's hypocholesterolemic effects.(13) Using both chemical and spectroscopic methods, the structure of a new withanolide, identified as 3 β ,14 α ,20 α F,27-tetrahydroxy-1-oxo-20R,22R-witha-5,24-dienolide, was determined.(14) Study comparisons with known closely related withanoloides have validated this structure's identity. Chemical and spectroscopic methods were applied to determine the presence of sitosterol--d-glucoside.(15) Apart from these, following are the phytochemicals that are present in *Withania coagulans*.

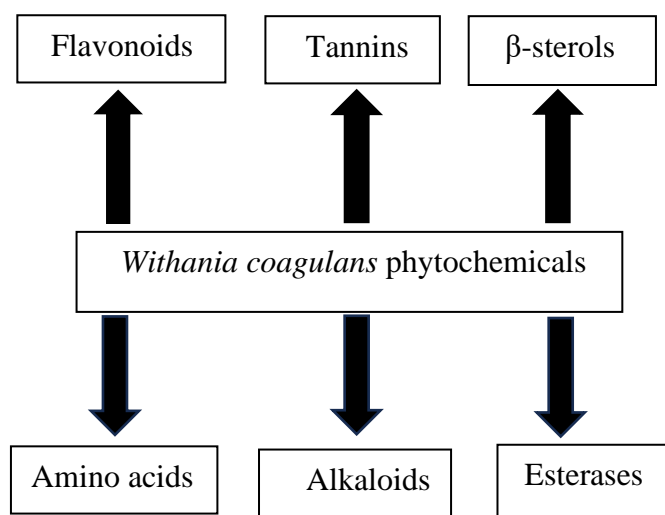
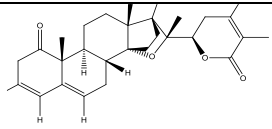
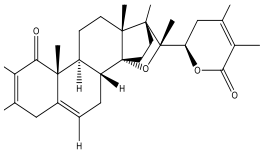
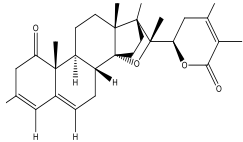
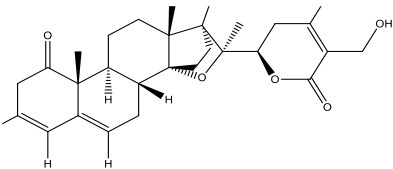
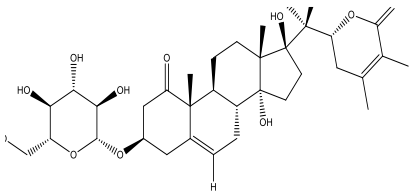
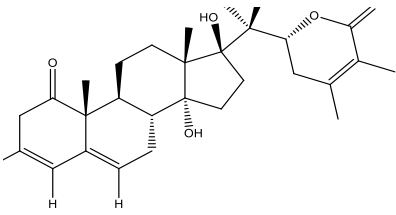


Table 1. Following are the isolated compounds from *Withania coagulans* with their reported Antihyperglycaemic activity

Sr No.	Name of the compound with structure	Plant part	Activity	Reference
1	Coagulin 	Whole plant	Antihyperglycaemic	(16)
2	Coagulin 	Whole plant & fruits	Antihyperglycaemic	(5)
3	Coagulin D 	Whole plant	Antihyperglycaemic	(7)
4	Coagulin F 	Whole plant	Antihyperglycaemic	(3)
5	Coagulin L 	Whole plant & fruits	Antihyperglycaemic	(2)

6	<p>Withanolide F</p> 	Fruits	Antihyperglycaemic	(2)
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Pharmacological Properties

This plant's fruits are used to cause milk to curdle. Ayurveda and the traditional Indian medical system have long incorporated Unani as a significant component. According to several reports, *withania coagulans* possess fascinating biological properties when isolated.(17) According to reports, the plant's fruit is sweet and tasty. Sedative, emetic, mood-altering, diuretic. They help with chronic liver problems; They are utilized as blood purifiers in specific places. Additionally, they are employed in therapy of bloating colic, other intestinal infections, and dyspepsia. They are also employed to treat asthma, bile problems, etc. (18)

Withania coagulans comprises the following Pharmacological functions:

1. Anti-diabetic activities:

Polyurea, polydipsia, hyperglycemia, blood sugar, and overall weakness are all symptoms of diabetes that may be related to weight loss. Every tissue and organ in the body is impacted by this disease, and it also causes it. Significant morbidity, decreased quality of life, and a shorter life expectancy.(19) At the maximum dose of 1g/kg, the water-containing extract of the berries of the *withania coagulans* fruit considerably dropped the level of blood sugar, triglycerides, plasma LPO, and liver LPO levels.(20) Additional plant fruit water-soluble extract at the same dose mitigates serum LPO levels also in the liver of streptozotocin-induced diabetic rats and db/db mice.(21) Orally administered to rats with diabetes induced by streptozotocin. Following treatment with the aforementioned medications, blood sugar levels in normal rats significantly decreased. In normoglycemic rats, treatment with coagulanolide along with four existing in the form of 1-3 and 5, extracted from four berries of *W. coagulans*.(22) *Withania coagulans* also showed In vitro free radical scavenging activity

utilizing DPPH.(23) It has been reported to control plasma glucose levels and prevent kidney complications. Among its many metabolites, the most noteworthy of which are the withanolides retrieved from its berries.(24)

2. Anti-inflammatory activities:

Withania coagulans alcoholic extract has an enormous anti-inflammatory action that benefits in acute inflammation mediated by the albumin found in eggs and the cotton pellet technique for forming granulation tissue.(25) In a carrageenin-induced rat paw edema hypothesis, the hydroalcoholic *Withania coagulans* fruits extracts indicated a major anti-inflammatory effect.(26)(27)

3. The hepatoprotective effect:

When 3 β -hydroxy-2,3-dihydrwithanolide F was tested for its ability to protect against CCl₄-induced hepatotoxicity, it was discovered to have a strong protective effect. Based on a weight-based juxtaposition of its protective traits, it was demonstrated to be more effective than hydrocortisone.(28) A statistical comparison showed that it is a more potent stimulant than hydrocortisone and had a substantial therapeutic effect.(29)

4. Cardiovascular effects:

A newly discovered withanolide with a distinct chemical composition that is related to a cardiac glycoside aglycone. (molecular weight 488 \pm 6, melting point degrees 260–261), was separated from the *Withania coagulans* berries and examined for potential effects on the cardiovascular system.(30) 5 mg per kilogram of body weight is the dosage. Withanolides moderately lowered blood pressure Blocked dog pressure (34 \pm 2.1 mm Hg) Atropine rather than mepyramine or propranolol. Inside the rabbit Langendorff's preparation and electrocardiography were created on this basis it showed myocardial depressant effects. However, in perfused frogs' hearts, it causes mild positive inotropy, a chronotropic effect.(31)

5. Diuretic effect:

Withania coagulans fruit extract was examined for its diuretic effects utilizing a mildly modified in vivo the Lipschitz test simulation using furosemide as the standard medication. The outcomes demonstrated a considerable increase in urine production at concentrations of

500 and 750 mg/kg, in that order, of 79.12% and 71.02%. When compared to the control, the excretion of urinary electrolytes increased in both individuals.(32) The diuretic action is related to the presence of polarity activating principles, withanolides as one of the chemical protagonists. In traditional medical practice, evidence justifies the therapeutic use *withania coagulans* as a diuretic.(33) The plant-based extract of *Withania coagulans* consists of hypotensive, respiratory euphoric and tissue-relaxing impacts.(34)

6. Anti-bacterial and synergistic activities:

Essential oils are containing antibacterial properties against the bacterium *Staphylococcus aureus* and is derived from alcoholic fruit extracts containing *withania coagulans*.(35) Hexane extract of *E. coli* roots and methanol extract of *S. Typhimurium* TA100 strain leaves and roots DH5a strain shown more or less synergistic effects.(36) Withaferin A and Withanolide D's presence in extracts is responsible for their antibacterial synergistic activity.(37)

7. Anti-cancer activities:

W. coagulans root, leaf, petiole, and fruit CME was tested for cytotoxic potential at a dose of 20 g/mL, potential 2 was tested against the HeLa, MCF-7, RD and or INS-1 and RG2. Chemicals (Including DMSO, CCM, and MTX) have been examined at a similar amount of the concentration for reference and concluded as an enabling measure for one component as well as a negative controls for the remaining two.(38) This is because, at the conclusion of period time of 72 hours of incubation, neither DMSO nor CCM had any discernible (p 0.05) effect on the cells are HeLa, RD, MCF-7, RG2, or INS-1. in HeLa cells, petioles showed the highest levels of activity, which was followed by the *w. Coghlan* berries extracts (>80% cell killing).(39) There is little to no variation in activity comparing petiole extract and fruit extract.(40) However, In both fruit and petiole extracts, RG2 as well as RD cells exhibited a similar pattern of action, with >80% cell killing seen at 20 µg/mL after 24 to 72 hours of incubation.(41)

8. The recuperation of wounds:

500 mg/kg body weight of the hydroalcoholic part of the methanol extract *withania coagulans* was administered topically.(42) Body weight administered orally into the streptozotocin-persuade diabetic rats of Both forms of the hydroalcoholic fraction, topically

Comparing diabetic controls to those treated with 10% w/w ointment and 500 mg/kg body weight orally, p.o., shown a significant increase in wound rate contraction.(43)

9. Antioxidant activities:

50% preliminary phytochemical studies of an ethanol extract of the roots were found to contain carbohydrates, proteins, and steroids anthraquinones, flavonoids, tannins, and phenols.(44) There are compounds and triterpenoids. (45) Nitric oxide free radical levels in plant extracts were found to be low to moderate when antioxidant activity was assessed. inhibitory activity according to DPPH method. Later compared the activities with rutin and ascorbic acid.(46)

10. Immunosuppressive effects:

Withanolide E along with Ashwagandha have diverse immunosuppressive actions on rats that are treated with thymocytes and human B and T cells.(47,48) Withanolides, which consist of coagulin-H, modulate various cellular activities involved in immunological actions, including the growth of lymphoid cells and the production of the mediator IL-2.(49) Its effects are equivalent to those of prednisolone. Because of its strong suppressive effect on lymphocyte growth, coagulin-H, Th-1 as opposed cell cytokines are generated. Coagulin-H is an anticoagulant. T-cell motivation generated by phytohaemagglutinin (PHA).(50)

11. Antitumor properties:

Antitumor properties of withaferin (3-hydroxy-2, 3-dihydro-withanolide F). A water-soluble extract of *Withania coagulans* possesses anticytotoxic effects.(51) The extract has a strong inhibitory action against DMSO-induced cytotoxic and reduces TNF- TNF-generation in chicken lymphoid cells.(52)

12. The activity of anthelmintics:

The essential oil extracted from the vaporization process of the petroleum ether extracted from the pulp of *Withania*, which is coagulans berries appears to have anthelmintic effects. In ruminating animals, the top sections of *Withania coagulans* show anthelmintic action.(53)

13. Antifungal activity:

Two new withanolides, 14, [(20S, 22R) 17,20-dihydroxy-14,15-epoxy-1-oxo-with a-3,5,24-trienolides] 15epoxywithanolides I along with 17-hydroxy withanolides K [(20S,22R)14,17,20-trihydroxy-1-oxo-with a-2,5,24-trien-olide], were discovered in an ethanolic extract of the complete plant.(54)

14. Anti-arteriosclerosis actions:

In a system in vitro that makes use of DPPH, a water-soluble extract of *Withania*, which is coagulan also demonstrates radical scavenging action. An aqueous solution of *Withania coagulans* fruits offers antioxidant potential against a variety of ailments such as aging, atherosclerosis, many others.(55)

CONCLUSION

In conclusion, there is a long and rich history of the use of herbal medicine that spans centuries, and it still plays a significant part in global healthcare. Herbal therapy offers a significant complement and alternative for a range of health and wellness requirements, even though modern medicine has made amazing strides and is crucial for many acute and severe conditions. Herbal medicines' efficacy and safety might differ greatly, and there may be interactions with other drugs or underlying medical issues. As a result, it's crucial to get guidance from a medical professional who is familiar with herbal remedies and who can assist in creating a treatment plan specific to your needs. *Withania coagulans* is known to contain a variety of substances like chemically and biologically active compounds, it is versatile and has great possibility for therapy. The compound's biological activities and potential medicinal uses have not received much attention. Therefore, an In-depth study is necessary to utilize them therapeutically benefits in fighting disease. In this review, we have discussed about *Withania Coagulans* and its therapeutic activities such as anti-diabetic activities, anti-inflammatory activities, hepatoprotective activity, cardiovascular effect, diuretic effect, anti-bacterial and synergistic activities, anti-cancer activities, wound healing activity, antioxidant activities, immunosuppressive effects, antitumor properties, anthelmintic activity, antifungal activity, anti-arteriosclerosis activity. Besides all these therapeutic activities *withania coagulans* can also show an increase in the testosterone levels in males. More investigations, yet, are required to validate its medicinal use. As a result, there is still

plenty of need for future scientific investigation into *Withania coagulans* to establish its medicinal efficacy as well as economic potential.

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REFERENCES

1. Fazio F, Habib SS, Naz S, Ullah M, Nawaz G, Nava V, et al. *Withania coagulans* fruit extract: a possible useful additive in ameliorating growth and immunity of *Labeo rohita* (Hamilton, 1822). *Nat Prod Res.* 2023 Mar 4;37(5):803–8.
2. Rakesh Maurya, Akansha, Jayendra. Chemistry and pharmacology of *Withania coagulans*: an Ayurvedic remedy. *Journal of Pharmacy and Pharmacology.* 2010;62(2):153–60.
3. Gupta PC. *WITHANIA COAGULANS* DUNAL- AN OVERVIEW. *International Journal of Pharmaceutical Sciences Review and Research.* 2012;12(2):68–71.
4. R. Barad, P. Soni, Miss Siddhi Upadhyay, U. Upadhyay. *WITHANIA COAGULANS* AND *PSIDIUM GUAJAVA*- AN OVERVIEW. *International Research Journal of Pharmaceutical and Applied Sciences.* 2013 Jun;30(3):42–7.
5. Gupta V, Keshari BB. *WITHANIA COAGULANS* DUNAL. (PANEER DODA): A REVIEW. *International Journal of Ayurvedic and Herbal Medicine.* 2013;3(5):1330–6.
6. Rupal Gupta, Tareeka Sonawane, Sandeep Pai. An overview of pharmaceutical properties and biotechnological advancement of *Withania coagulans*. *Advances in Traditional Medicine.* 2022 Feb;673–83.
7. Rohit J, Sumita K, S LK. Phytochemistry, pharmacology, and biotechnology of *Withania somnifera* and *Withania coagulans*: A review. *Journal of Medicinal Plants Research.* 2012 Oct 25;6(41):5388–99.
8. Khan MI, Maqsood M, Saeed RA, Alam A, Sahar A, Kieliszek M, et al. Phytochemistry, food application, and therapeutic potential of the medicinal plant (*Withania coagulans*): A review. *Molecules.* 2021 Nov 1;26(22).
9. Dudhe R. Biological activities of *Withania somnifera* [Internet]. Available from: <https://www.researchgate.net/publication/265245087>
10. Ahmad Z, Shaheen A, Wasi A, Rehman S ur, Tahseen S, Ramakrishnan M, et al. Biotechnological Intervention and Withanolide Production in *Withania Coagulans*. *Agronomy.* 2023 Jul 28;13(8):1997.
11. Chaghakaboodi Z, Kahrizi D, Nasiri J. Journal of Medicinal Plants and By-products Original Article Callus and hairy Root Induction in the Medicinal Plant of *Withania coagulans* (Stocks) Dunal. 2012.
12. Neogi P, Kawai M, Suzuki M. Withacoagin, a New Withanolide from *Withania coagulans* Roots. *Bull Chem Soc Jpn.* 1988;61(12):4479–81.
13. S. Hemalatha, Rajesh Kumar, Manish Kumar. Plant Review *Withania coagulans* Dunal: A Review. *Pharmacognosy Reviews [Phcog Rev].* 2008 Jul;2(4):351–8.
14. Mir SR, Ali M, Waris M, Sultana S. Chemical constituents from the fruits of *Withania coagulans* (Stocks) Dunal. Vol. 4, Trends in Phytochemical Research (TPR) Trends Phytochem. Res. 2020.
15. Pandey I, Nama K S. Withaniacoagulans (Stocks) Dunal A rare ethnomedicinal plant of the Western Rajasthan Desert. . *Int J Pharmaceut Biomed Res.* 2015; 2:34–40.
16. Das N. Isolation of Active Fractions and Evaluating its Antidiabetic Property By Estimating Enzyme Inhibitory Activity of Withanolides from *Withania coagulans* A multifaceted review journal in the field of pharmacy. 2023; Available from: <https://www.researchgate.net/publication/373106499>
17. Azmi MB, Khan F, Asif U, Khurshid B, Wadood A, Qureshi SA, et al. In Silico Characterization of *Withania coagulans* Bioactive Compounds as Potential Inhibitors of Hydroxymethylglutaryl (HMG-CoA) Reductase of *Mus musculus*. *ACS Omega.* 2023 Feb 7;8(5):5057–71.

18. Maurya R. Chemistry and pharmacology of *Withania coagulans*: an Ayurvedic remedy. *Journal of Pharmacy and Pharmacology*. 2010 Feb;62(2):153–60.
19. Jaiswal D, Rai PK, Watal G. Antidiabetic effect of *Withania coagulans* in experimental rats. *Indian Journal of Clinical Biochemistry*. 2009 Jan 8;24(1):88–93.
20. Hemalatha S, Wahi AK, Singh PN, Chansouria JPN. Hypoglycemic activity of *Withania coagulans* Dunal in streptozotocin-induced diabetic rats. *J Ethnopharmacol*. 2004 Aug;93(2–3):261–4.
21. Maher S, Choudhary MI, Saleem F, Rasheed S, Waheed I, Halim SA, et al. Isolation of Antidiabetic Withanolides from *Withania coagulans* Dunal and Their In Vitro and In Silico Validation. *Biology (Basel)*. 2020 Jul 30;9(8):197.
22. Maurya R, Akanksha, Jayendra, Singh AB, Srivastava AK. Coagulanolide, a withanolide from *Withania coagulans* fruits and antihyperglycemic activity. *Bioorg Med Chem Lett*. 2008 Dec 15;18(24):6534–7.
23. Maurya R, Akanksha, Jayendra, Singh AB, Srivastava AK. Coagulanolide, a withanolide from *Withania coagulans* fruits and antihyperglycemic activity. *Bioorg Med Chem Lett*. 2008 Dec;18(24):6534–7.
24. Patel D, Kumar R, Laloo D, Hemalatha S. Diabetes mellitus: An overview on its pharmacological aspects and reported medicinal plants having antidiabetic activity. *Asian Pac J Trop Biomed*. 2012 May;2(5):411–20.
25. Budhiraja RD, Bala S, Garg KN. Pharmacological investigations on fruits of *Withania coagulans*, Dunal. *Planta Medica*. 1977 Sep;32(06):154–7.
26. Ojha S, Alkaabi J, Amir N, Sheikh A, Agil A, Fahim MA, et al. *Withania coagulans* Fruit Extract Reduces Oxidative Stress and Inflammation in Kidneys of Streptozotocin-Induced Diabetic Rats. *Oxid Med Cell Longev*. 2014; 2014:1–9.
27. G. Singh, P. K. Sharma, R. Dudhe, S. Singh. Biological activities of *Withania somnifera*. *School Research Library*. 2010;1(3):56–63.
28. Budhiraja R D, Bala S, Craeg F N. Protective effect of 3-beta-hydroxy-2-3 dihydro withanolide-F against CCl₄ induced Hepatotoxicity. *Planta Medica*. 1986;52(1):28–9.
29. Khare CP. *Indian Medicinal Plants*. Springer-Verlag, Berlin/Heidelberg. 2007;
30. Niaz Ali, Bashir Ahmad, Shumaila Bashir, Manzoor Ahmad. Calcium channel blocking activities of *Withania coagulans*. *African Journal of Pharmacy and Pharmacology*. 2009;3(9):439–42.
31. Budhiraja RD, Sudhir S, Garg KN. Cardiovascular effects of a withanolide from *Withania coagulans*, dunal fruits. *Indian J Physiol Pharmacol*. 1983 Jun;27(2):129–34.
32. Dabheliya J, Khan A, Joshipura M, Vasoya M, Patel S, Vijaya S. DIURETIC POTENTIAL OF AQUEOUS EXTRACT OF FRUITS OF *WITHANIA COAGULANS* DUNAL IN EXPERIMENTAL RATS.
33. Prachi Govindrao Deshmukh, Swapnil Jaiswal, Deepak Bornare. A Review: Different Properties of *Withania Coagulans*. *J Emerg Technol Innov Res*. 2022 Aug;9(8):439–49.
34. Mathur D, Agrawal RC, Shrivastava V. Phytochemical Screening and Determination of Antioxidant Potential of Fruits Extracts of *Withania coagulans*. 2011;3(11):26–9. Available from: www.scholarjournals.orgwww.recent-science.com
35. Neelam B, Pratima S. Pharmaceutical Importance of *Withania Coagulans* In Health and Diseases.
36. Nazir I, Intisar A, Din MI, Khan JS, Ahmed E, Aamir A, et al. Volatile Composition and Antibacterial Activity of Fruits of *Withania coagulans* Dunal.
37. Vandana Gupta, Bipin Bihari Keshari. *WITHANIA COAGULANS* DUNAL. (PANEER DODA): A REVIEW. *International Journal of Ayurvedic and Herbal Medicine*. 2013;3(5):1330–6.
38. Maqsood M, Qureshi R, Ikram M, Ahmad MS, Jabeen B, Asi MR, et al. In vitro anticancer activities of *Withania coagulans* against HeLa, MCF-7, RD, RG2, and INS-1 cancer cells and phytochemical analysis. *Integr Med Res*. 2018 Jun;7(2):184–91.
39. Bare NB, Jadhav PS, Ponnuchamy M. DNA barcoding for species identification and phylogenetic investigation employing five genetic markers of *Withania coagulans*. *J Appl Biol Biotechnol*. 2023;
40. Scheck AC, Perry K, Hank NC, Clark WD. Anticancer activity of extracts derived from the mature roots of *Scutellaria baicalensis* on human malignant brain tumor cells. *BMC Complement Altern Med*. 2006 Aug 16;6.
41. Shukla S, Mehta A. Anticancer potential of medicinal plants and their phytochemicals: a review. *Brazilian Journal of Botany*. 2015; 38:199–210.
42. Prasad SK, Kumar R, Patel DK, Hemalatha S. Wound healing activity of *Withania coagulans* in streptozotocin-induced diabetic rats. *Pharm Biol*. 2010 Dec;48(12):1397–404.

43. Ojha S, Alkaabi J, Amir N, Sheikh A, Agil A, Fahim MA, et al. *Withania coagulans* Fruit Extract Reduces Oxidative Stress and Inflammation in Kidneys of Streptozotocin-Induced Diabetic Rats. *Oxid Med Cell Longev*. 2014; 2014:1–9.
44. P. Dehvari-Nagan, H. Abbaspour, M. H. Asare, S. Saadatmand. Melatonin Confers NaCl Tolerance in *Withania coagulans* L. by Maintaining Na⁺/K⁺ Homeostasis, Strengthening the Antioxidant Defense System and Modulating Withanolides Synthesis-Related Genes. *Russian Journal of Plant Physiology*. 2023;70(52):1–13.
45. Salwaan C, Singh A, Mittal A, Singh P. Investigation of the Pharmacognostical, Phytochemical and Antioxidant Studies of Plant *Withania coagulans* Dunal [Internet]. Vol. 1, *Journal of Pharmacognosy and Phytochemistry*. 2012. Available from: www.phytojournal.com
46. Maryam Allahdou, Marie Dorrazehi, Barat Ali Fakheri, Leila Mehravaran. Elicitation improves the production of bioactive compounds and antioxidant activity in the cell suspension culture of *Withania coagulans* (stocks) Dunal.
47. Atta-ur-Rahman, Choudhary MI, Qureshi S, Gul W, Yousaf M. Two New Ergostane-Type Steroidal Lactones from *Withania coagulans*. *J Nat Prod*. 1998 Jun 1;61(6):812–4.
48. B Shohat, I Kirson, D Lavie. Immunosuppressive activity of two plant steroidal lactones withaferin A and withanolide E. *National Library of Medicine*. 1978;28(1):18–24.
49. Shukla K, Dikshit P, Tyagi MK, Shukla R, Gambhir JK. Ameliorative effect of *Withania coagulans* on dyslipidemia and oxidative stress in nicotinamide–streptozotocin-induced diabetes mellitus. *Food and Chemical Toxicology*. 2012 Oct;50(10):3595–9.
50. Jain R, Kachhwaha S, Kothari SL. Phytochemistry, pharmacology, and biotechnology of *Withaniasomnifera* and *Withaniacoagulans*:. 2012;6(41):5388–99.
51. Hemalatha S, Kumar R, Kumar M. PHCOG REV.: Plant Review *Withania coagulans* Dunal: A Review [Internet]. Vol. 2, *Pharmacognosy Reviews [Phcog Rev]*. Available from: <http://www.phcogrev.com>
52. Valizadeh J, Valizadeh M. Development of efficient micropropagation protocol for *Withaniacoagulans* (Stocks) Dunal. *Afr J Biotechnol*. 2011;10(39):7611–6.
53. Mughal T, Shahid S, Qureshi S. ANTIFUNGAL STUDIES OF *WITHANIA COAGULANS* AND *TAMARIX APHYLLA*. Vol. 289, *Journal of Applied Pharmacy*. 2011.
54. Hasan M, Zafar A, Shahzadi I, Luo F, Hassan SG, Tariq T, et al. Fractionation of Biomolecules in *Withania coagulans* Extract for Bioreductive Nanoparticle Synthesis, Antifungal and Biofilm Activity. *Molecules*. 2020 Jul 31;25(15):3478.
55. Sharma S, Joshi A, Hemalatha S. Protective effect of *Withania coagulans* fruit extract on cisplatin-induced nephrotoxicity in rats. *Pharmacognosy Res*. 2017;9(4):354.