

An Overview of the Various Characteristics of *Withania coagulans*

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Abstract:- Many plants are useful in the traditional medicinal system for treating a wide range of conditions and illnesses. *W. Coagulans* (Stocks) Dunal (Solanaceae), known as the "Indian cheese maker", is an important medicinal plant classified as Indian or herbal organic plant. It is also known by trade names panir (or paneer) doda. *Withania coagulans* is a tiny shrub that grows throughout South Asia and the eastern Mediterranean region. It is a widely used medicinal herb in several regions of India and Pakistan. In Ayurvedic medicine, coagulococci are often used to treat diabetes. Withanolides isolated from the aqueous extract of the fruits of the plant have been shown to have excellent antihyperglycemic and antidyslipidemic activities, as well as wound healing, anti-inflammatory, hepatoprotective, hypolipidemic, and antifungal properties. The current review paper emphasises the importance of taxonomical classification, morphology, phytochemistry, species, botanical name, pharmacological action, and food applications. This extensive data will be very beneficial to researchers in the future.

Keywords:- Indian Cheese Maker, *Withania coagulans*, Withanolides, phytochemistry, Chemical Constituents, morphology, Pharmacological Properties.

I. INTRODUCTION

Withania has been used for millennia to cure ailments, preserve food, halt epidemics, and address health problems. Ayurveda means the science of life. Their healing powers have been understood and passed down via human communities over the years. One Many plants are considered to be helpful in the natural therapy system used to treat diabetes. There are two kinds of *withania*. The little bushes are native to India and can be found throughout the eastern Mediterranean region, which extends to South Asia. 2, 3 *Withania coagulans* belongs to the family Solanaceae. *W. coagulans* and *W. somnifera*, two of the twenty-three well-known species of *Withania*, are the only two that have economic significance.⁴ The Stocks of *W. Coagulans* Often referred to as the "Indian Cheese Maker," Dunal (Solanaceae) is an Indian organic compound or vegetable organic compound. Given that the plant's fruits are used to coagulate milk, it is sometimes marketed under the name panir (or paneer) doda.⁶ There hasn't been much study on the biotechnological qualities of this useful herb.⁵ *W. Coccinos* has garnered recognition. The Rishyagandha in Ayurveda.

The berry husk that is connected to the pulp of the fruit is thought to be responsible for the ability of the accelerator withanin to coagulate milk. 7 The berries are used to purify blood in several regions of the Indo-Pak subcontinent.⁸ The *W. Coagulans* berries are utilised in Punjab because they provide a coagulating accelerator for the milk's natural action, which is known as paneer.⁹ The leaves, fruit, and roots all have different medicinal properties. Berries are mostly composed of amino acids, alkaloids, withanolides, esterases, and essential oils.¹⁰ The natural action qualities of milk were assessed using a proteinase derived from the fruit of *Withania Coagulans*.¹¹ It is widely used in situations of diabetes⁹ Its nutritious fruit is important to the development of the newest medication.¹² The medication has demonstrated its own hepatoprotective, antifungal, cardiostimulant, anti-inflammatory, and wound-healing properties.¹³ There are rumours that the fruits contain various sedative, emetic, and diuretic drugs.¹⁴⁻¹⁵ The alcoholic extract of *W. coagulans* has been shown to possess antibacterial and anthelmintic properties, while the liquid extract of the plant's fruit included withanolide, which was found to have cardiovascular effects. The fruits of *W. coagulans* may be causing the increased glucose level to drop. The fruits of *W. coagulans* are hypoglycemic and antidiabetic, which may possibly be attributed to the essential presence of Mg and Ca in them.¹³ Owing to its broad therapeutic utility, it is important to get a variety of drug quality and quantity criteria in order to prevent adulteration.¹¹ It is often advised to use *W. Coagulans* in the dairy farm industry for the production of cheese and for cheese ripening. Casein degradation is caused by *W. activity*.¹³ Milk clotting in dairy farms may benefit from the fruit of *W. Coagulans* extract's mild clotting activity and warmth and cold resilience.⁶ The antioxidant qualities and phytochemical composition of the methanolic and liquid fruit extract of *W. Coagulans*.³ This study describes the purified properties of aspartic proteinase from the fruit of *W. coagulans*.¹⁶ Another alternative fruit to calf rennet for milk coagulation is *W. coagulans*.¹³ *Withania* is very important in Indian Ayurvedic medicine. It is a valuable and beneficial plant genus. The system is operational due to its beneficial properties as a medicine and functional food.⁴ Fruit *W. Coagulans* liquid extract showed antioxidant and antidiabetic properties.¹² A number of withanolides show promise in the management of neurodegenerative illnesses.² Numerous animal models have demonstrated the intelligent antihyperglycemic and antidyslipidemic action of withanolides that were extracted from the plant's liquid extract of fruits. It has also been demonstrated to possess anti-inflammatory, hepatoprotective,

hypolipidemic, antifungal, and cardio tonic properties as well as wound healing activity.¹⁷

➤ *Botanical description of Withania coagulans:*

- Botanical name: *Withania coagulans*
- Family: Solanaceae
- Subfamily: Solanoideae
- Tribe: Physaleae
- Subtribe: Withaninae
- Sanskrit name: Rishyagandha¹⁸⁻¹⁹
- Hindi name: Paneer doda Punir
- English name: Indian paneer maker, Indian rennet, vegetable rennet
- Trade name: Panir bed, Paneer dodi, Panner, doda, Paneer dhodi.

➤ *The colloquial term for Withania coagulans is:*

The plant goes by several names in several regional languages, including Javzulmizaja in Arabic and Kaknajehindi in Hindi.

- Canares: Asvagandhi
- Panneru-gadda in Telgu
- Urdu: Hab kaknaj
- Persian: Punirbad, Kaknajehindi
- Bengal: Asvagandha
- Mumbai: Kaknaj
- Gwalior: Asgandha
- Punjab: Punirjafota, Punirband²⁰; Sindhi: Punirjafota, Punirmira

II. MORPHOLOGICAL DESCRIPTION:



Fig (a) Flowers



Fig (b) fruits

- **Flowers:** Yellowish, dioecious, and polygamous in appearance, measuring 7 to 12 millimetres in diameter²¹. The blossoms appear to be very bright yellow or green, and they bear tiny, orange-red berries.⁷ Amount of flowering: January to Gregorian calendar month.²⁰
- **Fruits:** Berries are red, smooth, and roughly 7–12 millimetres in diameter. They are closely girt by an expanded, scurfy-pubescent membrane ringlet on the outside. Seeds: glabrous, somewhat auriform, 2.5–3 mm in diameter. Fruits are grouped together. Used as a carminative and depurative for upset stomach, flatulence, and odd²⁰⁻²¹. Berries contain volatile oil, fatty oil, alkaloids, free amino acids, esterase, and enzymes that coagulate milk. The volatile oil exhibited both anthelmintic and antimicrobial action against the genus

Micrococcus pyogenes power unit. aureus.²² Berries are utilised as a blood substitute.²³ Fruit W. Coagulans liquid extract shown inhibitory and medicinal properties.¹² From January to May, berries ripen. The seeds are the source of the natural regeneration.²⁰

- **Leaves:** Simple, complete leaves with a persistent greyish tomentum covering each side are present.¹ Usually gloomy, but measuring 2.5–5.7 by 1–2.2 cm in length²⁰. Axillary determinate clusters of yellow berries with smooth, red or chromatic, orbicular, basined coriaceous ringlets²². Withanolides are four internal secretion lactones found in leaves.²¹

➤ *Phytochemical property:*

Withaferin A is the most important withanolide found to date. Effective anti-tumour and antimicrobial qualities are present. Withaferin A, at a dosage of 10 ml, reduced the growth of several gramme-positive bacteria, acid-fast bacteria, aerobic bacteria, and pathogenic fungi. *Micrococcus pyogenes* was successfully killed by *Staphylococcus aureus* and *Bacillus subtilis* glucose-6-phosphate-dehydrogenase variants. In vitro testing of withaferin A against human carcinoma of the nasopharynx (KB) cell lines demonstrates a definite tumor-inhibitory effect. Furthermore, it functions as a mitotic toxin, preventing the metaphase division of cells cultured from human laryngeal carcinomas. Additionally, the studies revealed that radiosensitization and development inhibition were the outcomes of in vivo impacts on mice with Ehrlich ascites. Furthermore, in chicken embryonic fibroblast cells, it halted the mitotic process. Withaferin A demonstrates extremely effective anti-inflammatory and anti-arthritis action.³

Numerous withanolides (steroidal lactones) have been isolated from the whole plant of *W. coagulans*. These include coagulin F [27-hydroxy-14,20-epoxy-1-oxo-(22R)-Witha3,5,24-trienolide], coagulin G [17beta,27-epoxy-1-oxo-(22R)-with a-2,5, 24-trienolide], cogulanoide (17S,20S,22R)-[14alpha,15alpha,17beta,-tetrahydroxy-1-oxowitha-2,5,24-trienolide], 20beta- hydroxy-1-1-oxo (22R)-witha-2,5,24-trienolide, and withacoagulin.²⁴⁻²⁵

Previous phytochemical studies have demonstrated that the hypoglycemic impact of plants is caused by separated alkaloids and steroids from plant sources.

➤ *Novel Isolated Compounds of W. coagulans:*

Coagulans, coagunolide, and coagulins are the three newly isolated compounds of *W. coagulans*. Withanolide K, Choudhary et al. differentiated 17β-hydroxy: [13α,17β,20β-trihydroxy-1-oxo-witha-2,5,24-trienolide ((20S,22R)] Furthermore, the entire plant contains 17β,20β-dihydroxy-1-oxo-witha-2,5,24-trienolide. In essence, Shahwar²⁶⁻²⁷ discovered coagulin A coupled with ahejarin and asomniferine-An. Furthermore, thirteen coagulins (Coagulin F, G, H, I, J, K, L, M, N, O, P, Q, and R) were identified and separated from the entire plant. Several mixes, including some, have been identified in different *W. coagulans* specimens.²⁴⁻²⁸⁻²⁹ Coagulin U is also present in *W. coagulans*, along with other metabolites such as phytosterols (β-

sitosterol, β -sitosterol glycoside) and methyl-4-benzoate. Similarly, (22R),20 β -hydroxy-1-oxo linked to a 2,5,24-trienolide. Additionally, 22R also contains important components such as 3,5,25-trienolide and 14,20-epoxy-17 β -hydroxy-1-oxo.³⁰

Further identified were 17 β -hydroxy-14 α ,20 α -epoxy-1-oxo-(22R)-witha-3,5,24-trienolide and 17 β ,27-dihydroxy-14,20-epoxy-1-oxo-22R-witha-3,5,24-trienolide.²⁸ Coagulin S was also contained, and spectroscopic techniques were employed to clarify its structure.³¹ W. coagulans also produces coagulanolide and coagulansin B as metabolites.³²⁻³³ Withanolide H was unquestionably known, and withacoagulin J was identified as well as isolated.³⁴ It was also discovered that withanolide (20R, 22R)-14 α ,17,20 β ,27-trihydroxy-1-oxowitha-5,24-dienolide-27 β -(O- β -D-glucopyranoside) exists.³⁴⁻³⁵ Furthermore, five recognised

withanolides and withacogulanolide-B were included.³⁶ The compounds present in different plant parts are listed in Table 1. More identified compounds were 17 β -hydroxy-14 α ,20 α -epoxy-1-oxo-(22R)-witha-3,5,24-trienolide and 17 β ,27-dihydroxy-14,20-epoxy-1-oxo-22R-witha-3,5,24-trienolide.²⁸ Coagulin S was also contained, and spectroscopic techniques were employed to clarify its structure.³¹ W. coagulans also produces coagulanolide and coagulansin B as metabolites.³²⁻³³ Withanolide H was unquestionably known, and withacoagulin J was identified as well as isolated.³⁴ It was also discovered that withanolide (20R, 22R)-14 α ,17,20 β ,27-trihydroxy-1-oxowitha-5,24-dienolide-27 β -(O- β -D-glucopyranoside) exists.³⁴⁻³⁵ Furthermore, five recognised withanolides and withacogulanolide-B were included.³⁶ The compounds present in different plant parts are listed in Table 1.

Table 1: Significant constituents of roots, flying parts, leaves, and products of W. coagulans

| Molecules | Part of Plant | References |
|--|--------------------------------|------------|
| (20R,22R)-14,20 α ,27-trihydroxy-1-oxowitha-3,5,24-trienolide | Fruit | 37 |
| Coagulanolide (17S,20S,22R)-14 α ,15 α ,17 β ,20 β -tetrahydroxy-1-oxowitha-2,5,24-trienolide) | Fruit | 32 |
| Coagulin B, Coagulin C, Coagulin D, Coagulin E, Coagulin R | Aerial parts (leaves and stem) | 28-38 |
| (5,20 α (R)-dihydroxy-6 α ,7 α -epoxy-1-oxo-(5 α) witha-2,24-dienolide) | Aerial part (leaves) | 39 |
| Withaferin A | Root | 40 |
| (3 β -hydroxy-2,3-dihydrowithanolide F) | Fruit | 41 |
| Amyrin | Aerial parts (leaves and stem) | 30 |

III. PHARMACOLOGICAL ACTIONS

➤ *Antihyperlipidemic effects and Antihyperglycaemic:*

Pharmacological effects on the blood sugar, lipid profile, and body weight of individuals with type 2 diabetes were revealed by W. coagulans fruit extracts synthesised as aqueous and chloroform. These extracts also demonstrated antihyperglycaemic and antihyperlipidemic actions. When given alone or in combination with a mixture given orally once daily at a dose of 1 g/kg body weight for 14 days in various normoglycemic group and diabetic rats, the combination significantly lowers blood sugar levels of triglycerides, total cholesterol, LDL, and VLDL as well as glucose and increases HDL.⁴²⁻⁴³ Additionally, in both the streptozotocin-induced diabetic rats and the db/db rats, the same dose of an aqueous extract of the plant's fruits significantly reduced the levels of LPO in the liver and serum.⁴⁴⁻⁴⁵ One gramme per kilogramme of body weight

was found to be the dose of plant extract that decreased fasting blood glucose levels by a maximum of 33.2% at four hours. typical rats. But the glucose tolerance test The three-hour maximum reductions of 15.7, 28.9, and 37.8%, respectively, in normal, sub-, and slightly diabetic rats' studies validated the hypoglycemic and anti-diabetic action of W. coagulans aqueous extract.⁴⁶

In addition to diabetic rats generated by streptozotocin, treatment with coagulanolide and the previously stated withanolides 1-3 and 5 isolated from the fruits of W. coagulans exhibited a significant reduction of the postprandial rise in post-sucrose load hyperglycemia in normoglycemic rats. Compound 5 also considerably reduced blood during fasting, improved glucose tolerance and glucose profile in db/db mice, and chemical 5 showed antidyslipidemic activity against db/db animals. The average chemical 5's effective dose was found to be inducible

streptozotocin doses of approximately 25 mg/kg body weight rats with diabetes, which is similar to the usual The diabetes medication metformin. This clarifies the conventional W. coagulans used as an antihyperglycemic compound antidyslipidemic drug according to conventional medicine practitioners.⁴⁶

- **Healing Properties of Wounds:** The alcoholic portion of the methanolic extract of W. Coagulans was given topically at a percentage of 10% w/w and orally at a dose of 500 mg/kg body weight to diabetic rodents induced by streptozotocin. The hydroalcoholic division in both structures—oral (500 mg/kg body weight, p.) and effective (10 percent w/w treatment)—was observed in comparison to the diabetic controls. o—exhibited a crucial increase in the rate of wound closure.⁴⁷

➤ *Diabetes mellitus:*

Chronic diabetes mellitus affects people of all racial and socioeconomic backgrounds equally. The increased prevalence of diabetes is due to a more stressful, contemporary lifestyle; some individuals with the disease are even in their 30s or 40s.⁴⁶ Increased stress and poor eating habits with an increase in dependence on junk food are some of the factors. In addition to heredity and pollution, additional variables that are contributing to the rise in diabetes cases include smoking and increased tobacco usage. in young people. Sulphonylureas and biguanides, which are oral hypoglycemic medicines, continue to be the main competitors. Despite the increased interest in herbal therapies due to the potential adverse effects in the management of the condition consequences of the oral hypoglycemic medications.⁴⁸ Deep hypoglycemic action has been discovered for *Withania coagulans* Dunal. An efficient and secure alternative medication for diabetes, *Withania coagulans* Dunal showed hypoglycemic efficacy.⁴⁹ Deep hypoglycemic action has been discovered for *Withania coagulans* Dunal. An efficient and secure alternative medication for diabetes, *Withania coagulans* Dunal showed hypoglycemic efficacy.⁵⁰⁻⁴⁶⁻⁴⁴

➤ *Cardiovascular effects:*

A new withanolide (mol. what. m. p. 488. 260–261) was extracted from the coagulans fruits and examined for potential effects on the heart. Its chemical structure differed from that of the aglycones of the cardiac glycosides. 5 mg/kg of body weight as a dosage, withanolide caused a slight reduction in blood pressure. dog pressure (2 points, 1mm Hg) that was stopped by atropine rather than mepyramine or propranolol. The outcome of the ECG testing and Langendorff preparation was the rabbit. impacts on the heart, but in perfused frogs, it had a marginally favorable inotropic and time-related effect.⁴¹

➤ *Hepatoprotective effects:*

When the W-derived 3-hydroxy-2,3-dihydrowithanolide F molecule is present. After coagulans' potential to avert CCl₄-induced hepatotoxicity was investigated, it was found that the substance exhibited a discernible protective effect. An analysis of its superior active

defensive qualities compared to hydrocortisone based on weight.⁵¹

➤ *Diuretic effect:*

The diuretic efficacy of the aqueous extract of W was investigated using the in vivo Lipschitz test paradigm, with a few minor modifications and furosemide as a reference medication. Coagulans fruit. The results showed that there was a significant increase in urine volume. at 500 mg/kg and 750 mg/kg, respectively, by 71.02 percent and 79.12 percent. body weight dosages relative to the controls, correspondingly. Comparing both dosages to controls, there was an increase in the excretion of urine electrolytes.⁵²

➤ *Anti-inflammatory activity:*

A distinct W. It has been shown that coagulans fruit extracts have anti-inflammatory properties.⁵³

➤ *Antifungal activity:*

14,15-epoxywithanolide I [(20S,22R) 17,20-dihydroxy-14,15-epoxy-1-oxowitha-3,5,24-trienolide] and its counterpart are two novel withanolides. and K (20S,22R) 17-hydroxywithanolide 14 α ,17 β ,20 β -trihydroxy-1-oxo-witha-2,5,24-trien-olide], obtained from the entire ethanolic extract W. coagulans plant has been discovered to be active. against a variety of fungi that could be harmful.⁵⁴

➤ *Activities against bacteria and helminths:*

Activities against bacteria and helminths: It has been found that the volatile oil derived from the alcoholic extract of W.Coagulans fruits have antibacterial properties against *Vibrio cholera* and *S. aureus*. capable of combating helminths.⁵⁵⁻⁵⁶

➤ *Diseases of the Central Nervous System:*

Remarkably effective treatments for a number of CNS disorders have been found using the bioactive metabolites isolated from withania, including epilepsy, anxiety, depression, catalepsy, and sleep disorders. According to reports, the central nervous system is present in the whole extract of *Withania coagulans* found in dunal fruit. Activity of (CNS) depressants in dogs, rabbits, and mice.⁴⁴⁻⁵⁷

➤ *Alzheimer's disease:*

Alzheimer's disease is a neurological disease that causes memory loss and cognitive decline due to the death of brain cells. Dementia is a neurological form that begins mildly and worsens over time. Additionally, withanolides are said to prevent metastasis and inhibit the activity of quinone reductase. Several have been demonstrated to preferentially influence cortical and basal forebrain events in the cholinergic signaling cascade for the treatment of Alzheimer's disease.²²

➤ *Hypolipidaemic activity:*

Mice with newt-induced hyperlipidemia were administered aqueous extract of W. coagulans fruit (1 g/kg orally), which resulted in a 15% reduction in serum cholesterol levels compared to untreated mice. The aqueous extract administered at the same dose for 7 days to rats that had developed hyperlipidemia due to a high-fat diet resulted

in a significant decrease in body weight and higher levels of lipoproteins, triglycerides, and serum cholesterol. In animals fed aqueous extracts of *W. coagulans* and *Navaka guggulu* fruits, the reference preparation showed microvesicular changes combined with fewer degenerative changes. Fat transformation⁴³

Rats with Triton-induced hyperlipidemia that had a 15% drop in serum cholesterol levels when compared to untreated mice were given an aqueous extract of *W. coagulans* fruits (1 g/kg; p.o.). In rats who had developed hyperlipidemia due to a high-fat diet, the watery extract given for seven days at the same dosage weeks revealed a markedly lower body weight, higher serum levels of lipoproteins, triglycerides, and cholesterol. The animals given an aqueous fruit extract treatment of *W. coagulans* and *Navaka guggulu*, the reference medication displayed microvesicular alterations combined with fewer degenerative changes. fat modifications⁴³

➤ *Free Radical Scavenging Activity:*

Aqueous extract (2 mg/ml) showed free radical scavenging activity in an in vitro method using 1,1-diphenyl-2-trinitrophenylhydrazine (DPPH). Reducing free radical scavenging activity is the basis of this technology. Colour radical DPPH in methanol solution. The decrease in DPPH absorption at the 517 nm absorption maximum is related to the amount of radical scavenger added to the DPPH reagent mixture. The advantage of offering games is fifty percent. Its ability to eliminate free radicals may help prevent oxidative damage to pancreatic beta cells.⁴⁴

➤ *Antitumour activity:*

In in vitro tests on human nasopharyngeal carcinoma cells, withaferin A demonstrated potent tumor suppressor activity (KB).⁵⁸ Withaferin A prevented RNA formation by tumor cells. Ascites sarcoma-180. When reaching 40 mcg/ml. RNA inhibition was observed after incubation for 30 min. More than 50% synthetic. This caused protein production to stop. 180 sarcoma cells. Accordingly, Withaferin A inhibited transcription and translation processes in these cells.⁵⁹ At doses of 0.01–0.5%, *Allium cepa* root development was inhibited, leading to the arrest of cell division at metaphase 2 hours after treatment.⁶⁰ Withaferin A inhibited cell division in cells. The division stopped. Human cultured cells act as mitotic toxins. Metaphase laryngeal cancer cells. There was a similar but less pronounced effect on chick embryo fibroblasts and HeLa cells.⁵⁹⁻⁶⁰ Factor kappa B-activated withaferin A slowed cell proliferation in HUVECs at significantly higher doses, less than those required for tumor cell lines, through a procedure involving cyclin D1 inhibition.⁶¹

IV. CONCLUSION

The many parts of *Withania coagulans*, such as the berries, leaves, roots, etc., have different biological activities. Many phytochemicals, including alkaloids, withanolides, fatty oils, essential oils, free amino acids, and enzymes, have been extracted from this plant, making it a significant medicinal herb. Steroid lactones are called withanolides. possessing notable pharmacological properties.

Multitudinous exploration examinations have demonstrated the remedial rates of *Withania coagulans*, including hepatoprotective, anti-inflammatory, antihyperglycemic, free radical scavenging, hypolipidemic, antibacterial, and cardiovascular goods. unborn exploration on this factory is needed to completely understand its mode of action and impact on other conditions. It may be regarded as a great ayurvedic medication in the future for the treatment of numerous illnesses.

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