

## A Brief Review on Withania Coagulans

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### ABSTRACT

Withania Coagulans Dunal, (Rishyagandha) belonging to the family Solanaceae, Withania coagulans (Stocks) Dunal is used in traditional medicine to treat diseases and has numerous pharmacological properties due to its biological compounds. The plant is a subshrub native to Asia, especially the tropical and temperate regions of western Asia. Its medicinal effects derive from its biological components, which are linked to human health. Conventional medicine uses these compounds to treat a variety of diseases, such as neurological issues, diabetes, and asthma. The long-term benefits of W. Coagulans necessitate conservation strategies and plant biotechnological techniques such as micro propagation, synthetic seed, cell suspension, and hairy root elicitation technology, and genetic transformation can all play significant roles in conservation and sustainable utilization of the biological compounds for clinical uses. The objective of this review is to provide a comprehensive overview of the W. Coagulans medicinal properties, potential applications, and innovative approaches for sustainable utilization, making it a unique contribution to the existing body of knowledge. Multi-omics methods for the production of withanolides were also examined in order to gain a better understanding of the genome structure, prospective genes, and candidate proteins involved in the production.

**Keywords:** Ethnomedicines; Genetic Engineering; Pharmacological Activities; Secondary Metabolites; Tissue Culture; Transcriptomic.

### I. INTRODUCTION

Withania coagulans Dunal (synonym: Puneeria coagulans Stocks), commonly known as Indian rennet, is distributed in the drier parts of India. The plant is native of the Asia-temperate (Western Asia: Afghanistan) and Asia-tropical

(Indian Subcontinent: India, Nepal) regions. A survey of the literature has shown that in various traditional systems of medicine the plant has been recommended for the treatment of various disorders. It is an erect greyish under-shrub, 60–120 cm high<sup>[2]</sup>. This plant is widely used to coagulate milk due to the presence of an enzyme in its berries, which is commonly known as an Indian cheesemaker fig 1.2 depicts the leaves, stems, and fruit of the W. Coagulans plant.<sup>[2]</sup>



Figure 1.1 W.Coagulansplant<sup>(3)</sup>



Figure 1.2 (A) Leaves, (B) Fruits, (C) Stems<sup>(4)</sup>

## II. LITERATURE REVIEW

**Plants name:** - Rishyagandha, Withania Coagulans (paneer dodi)<sup>[2]</sup>

**Synonyms:** -

|         |                                                      |
|---------|------------------------------------------------------|
| Hindi   | Panir dodi, Panirkephool, Panir bandh.               |
| English | Indian rennet, Indian cheese maker, vegetable rennet |
| Chinese | Ning gu shui qie                                     |

Table no 1.1: Synonym of Panir Dodi<sup>[5]</sup>



Figure no 1.3 Berries of plant<sup>[6]</sup>

**Family:** - Solanaceae or nightshade family.<sup>[5]</sup>

**Botanical name:** Withania Coagulans<sup>[5]</sup>

**Biological Source:** Parts of shrub of Withania Coagulans are used which belong to genus Withania<sup>[5]</sup>

**Geographical Source:** - It is grown in various regions of the world such as in the Mediterranean region and from North Africa to South Asia<sup>[5]</sup>

**Distribution:** -Withania Coagulans is believed to have oriental origin. It is found wild in the forests of Mandsaur and

Bastar in Madhya Pradesh, the foot hills of Punjab, Himachal Pradesh, Uttar Pradesh and western Himalayas in India. It is also found wild in the Mediterranean region in North America. In India it is cultivated in Madhya Pradesh, Rajasthan and other drier parts of the country.<sup>[28]</sup>



Figure 1.4 Leaves and flowers of Withania Coagulans<sup>[28]</sup>

### Macroscopic Characteristics

**Size** - shrub 2-3m in length, ridges, and furrows are present.

**Branching** - perennial.

**Leaves**- simple 2–6cm wide, 3–8cm long.

**Colour**- yellowish-brown.

**Shape**- seeds are rounded.

**Flowering period**- January to April <sup>[7]</sup>

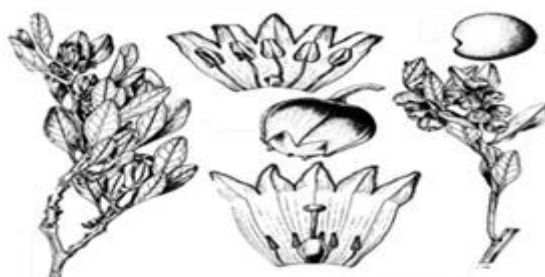


Fig 1.5 Macroscopic view of Parts of plant.

### The Taxonomic Classification of *W. coagulans* <sup>[8]</sup>

|                |                                 |
|----------------|---------------------------------|
| Kingdom        | Plantae, Plants                 |
| Sub-Kingdom    | Tracheobionta, Vascular Plants, |
| Super-Division | Spermatophyte                   |
| Division       | Angiosperma                     |
| Class          | Dicotyledons                    |
| Order          | Tubiflorae                      |
| Family         | Solanaceae                      |
| Genus          | Withania                        |
| Species        | Coagulans                       |

Table no. 1.2 The Taxonomic Classification of *W. coagulans* <sup>[8]</sup>

### Morphology

➤ *Withania coagulans* is a perennial shrub or small tree that typically grows up to 2-3 meters in height. <sup>[7]</sup>



Figure 1.5 Dunals of *Withania Coagulans* <sup>[28]</sup>

- **Shrub**: Branched, 2-3m in length, ridge and furrows is present, slightly hairy stem cylindrical, 0.5-0.16cm length, hair curved. <sup>[15]</sup>

- **Lamina**: Oval to oblong, 1-6 cm length, 0.3-2.6 cm width, margin smooth, thick apex obtuse, more than one leaf arise from one point, base oblique, mid-rib wavy. <sup>[15]</sup>

- **Inflorescence:** Axillary cymose, globose.<sup>[15]</sup>
- **Flowers:** Flowers ( figure 1) are yellow, 0.7-0.9 cm in length 0.4-0.5 cm width, oblong to lanceolate, pubescent, sepals green, densely hairy ovate, completely adnate except tips. Petals 5, yellow margin serrulate, apex, obtuse, 0.8-1.2 cm long, 0.3-0.4cm wide. Stamens 5, filament thin and straight, 0.4-0.5cm long. Ovary 2-loculed, fruit berry enclosed in enlarged calyx, dehiscent regularly. Anthers are elongated, 0.3-0.4 cm long, ribs prominent, rarely hairy.<sup>[15]</sup>
- **Fruit:** berry, globose, 1.5-1 cm long, 0.7-1 cm width, Sepals covers the fruit and ended into crownlike structure<sup>[15]</sup>.
- **Seeds :** Oval to rounded, yellowish brown, 41-59 in number, 0.1-0.3cm long, 0.2-0.3cm wide, dotted.<sup>[15]</sup>

#### Microscopy

- The transverse section of the pedicel shows a single layer of epidermis composing of tabular cells, covered with a large number of branched and unbranched trichome, and followed by cortex composing of 5-10 layers of collenchymatous cells.<sup>[9]</sup>
- The pericycle shows the presence of pericyclic fibers with intervening parenchymatous cells. The central region consisting of a narrow band of phloem encircling the xylem beneath which is a ring of intra-axillary phloem. The center most region is consisting of hollow pith surrounded by parenchymatous cells with a few thick-walled lignified fibers towards phloem
- The transverse section of calyx exhibits a single layer of thin-walled cells in both upper and lower epidermis with a few branched and unicellular covering trichomes present in upper epidermis. The mesophyll is represented by spongy parenchyma traversed by a number of small veins covered with bundle sheath cells composed of thin walled parenchymatous cells<sup>[9]</sup>.
- The transverse section of pericarp (fruit wall) shows the presence of exocarp which consists of a single layer of cells while mesocarp shows a wide zone of parenchymatous cells with strong cellulosic thickening. The endocarp is consists of single layer of cells.

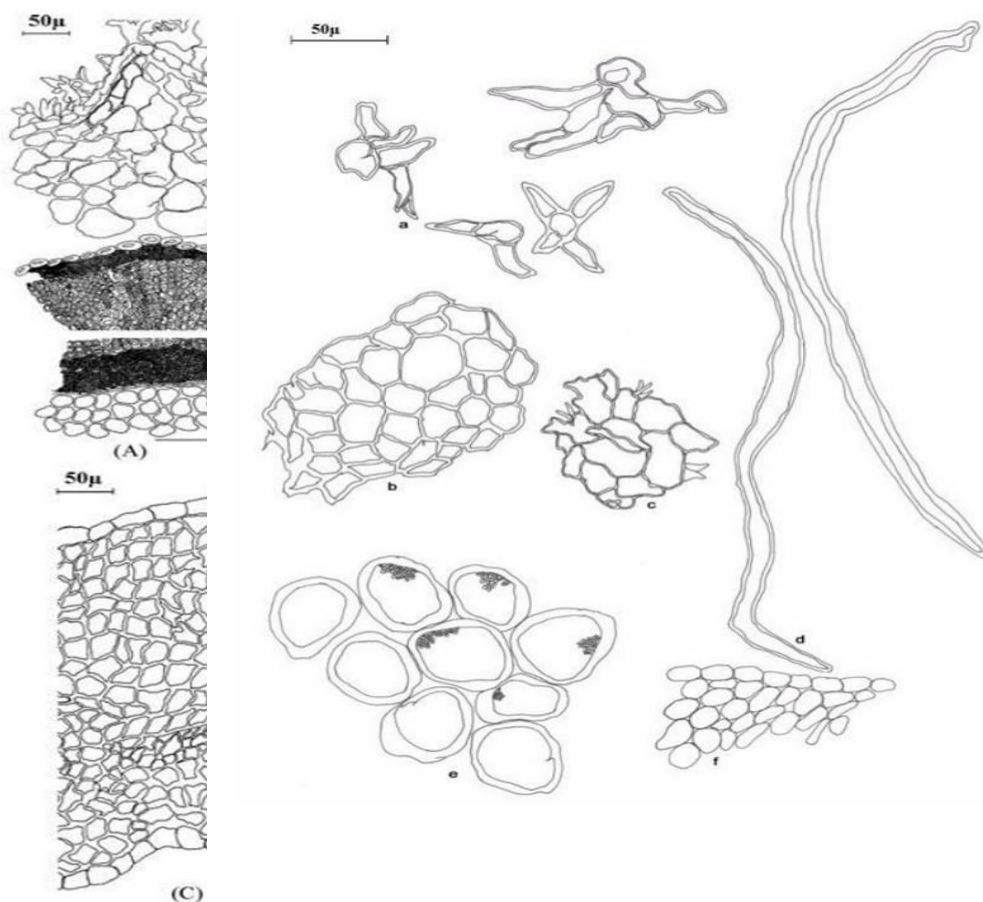


Fig 1.6 *Withania coagulans* Dunal: A. Transverse section of pedicel; B. Transverse section of calyx; C. Transverse section of pericarp; D. Transverse section of seed<sup>[9]</sup>.



Fig 1.7 *Withania coagulans* Dunal: Powder characteristics of fruits. A. Trichomes; B. Pericarp in surface view; C. Upper epidermis of calyx; D. Fiber; E. Endosperm cells with aleurone grains; F. Portion of cotyledons.<sup>[9]</sup>

### History

*W. Coagulans* in classical medicine and the subsequent commercialization in modern medicine, numerous studies have been conducted to identify, isolate and characterize various phytochemicals from different parts of the plant: among these, steroid lactones, tannins, flavonoids, terpenoids, iridoids, alkaloids and others have been found.

The presence of aerial wtds in *w. Coagulans*, The plant's berries are a rich source of essential oils, amino acids, and alkaloids, including a milk-coagulating enzyme called Indian cheese maker. Wtds-c-28 steroid lactones are the main chemical ingredient. They are found in plant leaves and roots (0.001 to 0.5% dry weight). *W. Coagulans* produces various wtd derivatives, including withanolid-a, physalins, withanolides-glycosides, withaphysalins, acnistins, perculactones, jabrols, daromaticwtds, and coagulin l, its most important component.<sup>[10]</sup>

### Nutritional Profile

➤ *W. coagulans* is a renowned herb due to its ethno pharmacological properties. It has been

utilized as a herbal remedy and is widely distributed in Iran, Pakistan, Afghanistan, and East India. *W. coagulans* is a good source of macro and micronutrients. The mineral composition of *W. coagulans* is summarized in Table 2.4.

➤ It contains a small fraction of moisture, protein, fat, and fiber and is also a good source of carbohydrates. Studies also indicate a higher amount of magnesium (greater than *Alhagi maurorum*, *Berberis lyceum*, and *Tecomella undulate*), calcium (greater than *Dature Alba*, *A. maurorum*, *Chenopodium album*, *B. lyceum*, *T. undulate*), potassium (greater than *B. lyceum* and *T. undulate*), and iron (greater than *D. Alba*, *B. lyceum*, and *T. undulata*) in *W. coagulans*. Roots are composed of ash (1.92%), carbohydrates (75.71%), lipids (5.5%), protein (2.95%), and fiber (5.76%). Leaves are composed of ash (3.26%), carbohydrates (65.31%), lipids (5%), protein (2.95%), and fiber (11.76%). Moreover, fruit contains ash (4.21%), carbohydrates(60.14%), lipids (5%), and protein (4.65%)<sup>[11]</sup>

| Minerals (mg/kg)        |        |
|-------------------------|--------|
| <b>Macro-Minerals</b>   |        |
| Calcium                 | 9260   |
| Magnesium               | 35,280 |
| <b>Minerals (mg/kg)</b> |        |
| Potassium               | 2450   |
| Sodium                  | 125    |
| <b>Micro-Minerals</b>   |        |
| Iron                    | 98.8   |
| Copper                  | 2.2    |

|          |      |
|----------|------|
| Zinc     | 40.2 |
| Chromium | 0.6  |
| Cadmium  | 1.4  |
| Lead     | 1.9  |
| Nickel   | 1.8  |

Table 1.3 Mineral composition of *W. coagulans*.<sup>[11]</sup>

### Chemical Constituents.

- *W. coagulans* is rich in steroidal lactones, which are known as withanolides (Figure 2.7). Withanolides are naturally occurring polyhydroxy C<sub>28</sub> steroidal lactones. In the basic structure of all withanolides a six- or five-membered lactone or lactol ring is attached to an intact or rearranged ergostane skeleton.
- *W. Coagulans* are rich in **Steroidal lactones** which are known as Withanolides.<sup>[12]</sup>

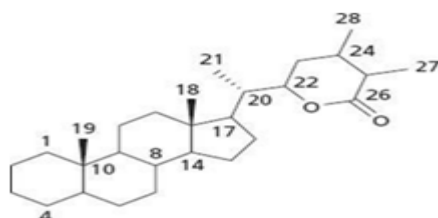


Fig 1.8 Basic skeleton of *Withania coagulans* withanolides<sup>[12]</sup>

### Novel Isolated Compounds of *W. Coagulans*.

- Several compounds have been identified in different parts of *W. Coagulans* including certain coagulans, coagulanolide, and coagulins. Identified 17 $\beta$ -hydroxywithanolide K: [(20S, 22R) 14 $\alpha$ , 17 $\beta$ , 20 $\beta$ -trihydroxy-1-oxo-witha-2, 5, 24-trienolide] and 17 $\beta$ ,20 $\beta$ -dihydroxy-1-oxo witha-2,5,24-trienolide in

whole plant. Similarly, found withahejarin, withasomniferine-A along with coagulin A. Furthermore, identification and isolation of thirteen coagulins (Coagulin F, G, H, I, J, K, L, M, N, O, P, Q, and R) from the whole plant was reported.

- *W. Coagulans* also contains coagulin U along with other metabolites such as methyl-4 benzoate and phytosterols ( $\beta$ -sitosterol,  $\beta$ -sitosterol glycoside). Similarly (22R),20 $\beta$ -hydroxy 1-oxowitha-2,5,24-trienolide and (22R)-14,20-epoxy-17 $\beta$ -hydroxy-1-oxowitha-3,5,25 trienolide which are also important constituents of it. Moreover, 17 $\beta$ ,27-dihydroxy-14,20 epoxy-1-oxo-22R-witha-3,5,24-trienolide and 17 $\beta$ -hydroxy-14 $\alpha$ ,20 $\alpha$ -epoxy-1-oxo-(22R) witha-3,5,24-trienolide were discovered.
- Coagulin S was also isolated, and its structure was elucidated by using spectroscopic techniques. Coagulans B and coagulanolide are also amongst the metabolites of *W. Coagulans*.
- Witha coagulin J was identified as well as isolated along with already known withanolides H. Withanolides named as (20R,22R)-14 $\alpha$ ,17,20 $\beta$ ,27-trihydroxy-1-oxowitha 5,24-dienolide-27 $\beta$ -(O- $\beta$ -D-glucopyranoside) was also discovered latterly. Furthermore, the structures of some withanolides are presented in fig 1.9<sup>[11]</sup>

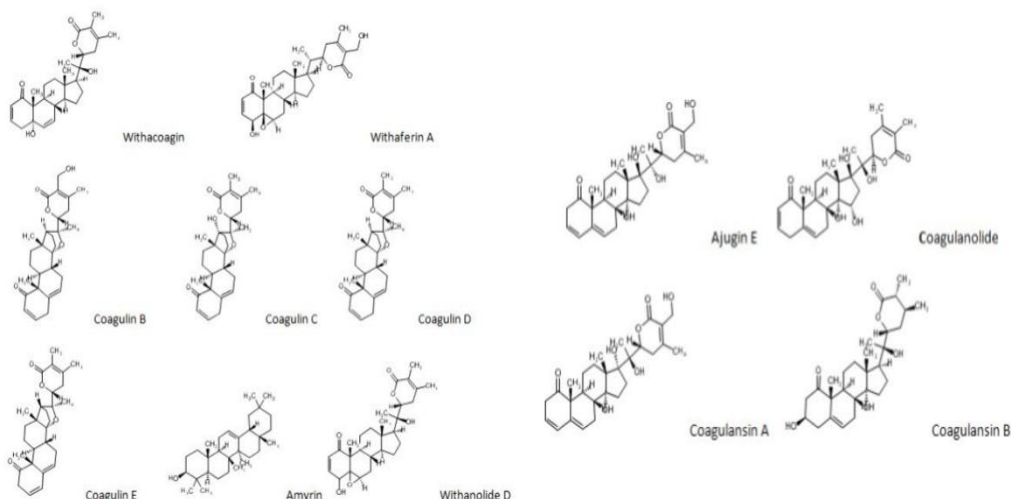


Fig 1.9 Isolated chemical constituents present in the plant <sup>[11]</sup>

#### Therapeutic Potential: -

- A number of medicinal properties are attributed to *W. coagulans* such as antifungal, anti-cytotoxic, antidiabetic, hypolipidemic, neuroprotective, anti-inflammatory, anti-

cancerous, anthelmintic, antioxidant activity, and wound healing activity.

- Various pharmacological and therapeutic activities of *W. coagulans* are attributed to the various plant parts including roots, leaves, and fruits.<sup>[11]</sup>

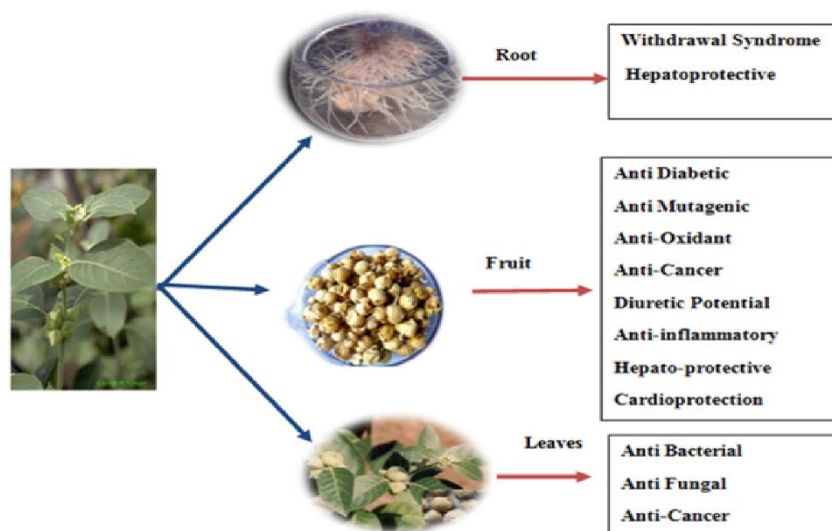


Fig 2.0 Therapeutic effect of different parts of plant. <sup>[11]</sup>

#### ❖ Therapeutic Use of Various Parts: -

| PARTS OF PLANTS | USES/USES                                                                                   |
|-----------------|---------------------------------------------------------------------------------------------|
| Fruits          | Asthma, biliousness, applied to the wounds <sup>[13]</sup>                                  |
| Ripe fruits     | Sedative property and are alternative, diuretic and are useful in chronic liver complaints. |
| Dried fruit     | Flatulent colic, dyspepsia and other intestinal affections                                  |
| Berries         | Blood purification                                                                          |



|         |                                                                                                 |
|---------|-------------------------------------------------------------------------------------------------|
| Flowers | Treatment of diabetes                                                                           |
| Seeds   | Useful in ophthalmic, lumbago and lessen the inflammation of piles. It also has diuretic effect |
| Twigs   | Cleaning teeth                                                                                  |

Table 1.4: uses of various parts of W. Coagulans<sup>[13]</sup>

#### Different Extracts Withanolides and Their Applications:-

| Extract                       | Application                                                                                                                               |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Aqueous extract</b>        | The dose of 10 mg/kg can also treat diabetes The dose of 2 mg/mL helps in the protection of pancreatic beta cell against oxidative damage |
| <b>Chloroform extract</b>     | Decrease the level of glucose, cholesterol, triglyceride, low density lipoprotein in blood at a dosage of 1 g per kg                      |
| <b>Alcoholic extract</b>      | Anti-inflammatory effect in acute inflammation                                                                                            |
| <b>Methanolic extract</b>     | Wound healing effect, apoptotic activity, anticancer activity                                                                             |
| <b>Volatile oil extracted</b> | Antibacterial and anthelmintic activity against Vibrio cholera and S. aureus                                                              |

Table 2.5: Different extracts withanolides and their applications<sup>[13]</sup>

#### ❖ Other Therapeutic Uses:

- The fruits is sweet; applied to wounds; used in asthma, biliousness strangury. The seeds are emmenagogue, diuretic; useful in lumbago, ophthalmia; 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. They are used as an emetic.
- 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. Honig Berger says that the bitter leaves are given as febrifuge by the Luhanes. In Bombay, the berries have a reputation as blood purifiers.
- 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).
- In Northern India traditional healers use dry fruits for the treatment of Diabetes mellitus.
- It has also antimicrobial, anthelmintic, antifungal, hepatoprotective, hypoglycaemic, hypolipidemic, cardiovascular, free radical scavenging, anti-inflammatory, antitumor, immunosuppressive, depressant property<sup>[22]</sup>

#### 1. Antidiabetic activity & Anti-oxidant activity

- Diabetes treatment: This plant will be more effective at proper concentration for diabetes is studied in male albino wistar rats by introducing diabetes causing chemical Streptozotocin (STZ). Due to STZ, the rats showed significantly increase in catabolic reactions, plasma glucose level, kidney weight and decrease in body weight and serum insulin. By above experiment it has been prove that the dose of approximately 10 gm per day per human is required for curing diabetes.<sup>[13]</sup>
- The aqueous extract of W. coagulans, helps to lower glucose level in the blood plasma if taken regularly for 14 days. The aqueous extract of fruit is drunk by diabetic people along with the intake of allopathic medicine for about a month is very effective. A continuous treatment for at least 2 months helps to control the blood sugar levels.<sup>[13]</sup>
- The flowers and fruits of paneer dodi are often used in folk medicine to manage diabetes. In an animal model with type 2 diabetes, paneer dodi was discovered to improve signs and symptoms while achieving normal blood glucose levels during the trial.
- The **Aqueous extract** of *Withania Coagulans* Dunal dried fruits (WCDFs) has been shown to possess an effective antidiabetic activity at a dose of 1 g/kg body weight in Streptozotocin-induced diabetic rats without any discernible toxic effect.<sup>[14]</sup>

#### Detailed Study of *Withania Coagulans*.: - Pharmacological Actions.

## 2. Hepatoprotective activity

- The aqueous extract of fruits of this plant has been shown to exert hepatoprotective activity. Since the steroidal compounds (glucocorticoids) having anti-inflammatory properties are used in some hepatic disorders, 3- $\beta$ -hydroxy-2, 3 dihydrowithanolide F has been screened for its hepatoprotective effect. It has shown hepatoprotective activity against  $\text{CCl}_4$ -induced hepatotoxicity in adult albino rats of either sex (150–200 g) at 10 mg/kg (i.p.).
- The protective effect was assessed by observing pentobarbitone (30 mg/kg; i.p.)-induced hypnosis, the determination of Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyruvic Transaminase (SGPT) levels, and histopathological examination of hepatic tissues after staining with haematoxylin and eosin solutions. Concomitant treatment of the rats with 10 mg/kg withanolides protected the liver significantly.<sup>[8]</sup>

## 3. Anti-Microbial and activity

- The fruits of *W. coagulans* contain volatile oil which showed antibacterial activity against *Staphylococcus aureus* and *Vibrio cholera*. From the ethanolic extract of the leaves withanolides were isolated and was found to have antibacterial properties. 17 $\beta$ -hydroxywithanolide K (20S, 22R) 14 $\alpha$ , 17 $\beta$ , 20 $\beta$ -trihydroxy- 1-oxo-witha-2, 5, 24- trien-olide extracted from the whole plant was found to be active against a number of potentially pathogenic fungi.<sup>[10]</sup>
- The antifungal activity of the crude extract, 17 $\beta$ -hydroxyl withanoloid k and withanolides F were tested against nine highly pathogenic isolated fungi i.e. *Nigrospora oryzae*, *Aspergillus Niger*, *Curvularialanata*, *Pleuretus ostreatus*, *Stachybotrysatra*, *Allescheria boydii*, *Drechslera rostrate*, *Microsporumcanis*, and *Epidermo-phyton floccosum*. The compound also showed activity against gram positive (*S. aureus*).
- The essential oil is active against *Micrococcus pyogenes* var. *aureus* and *Vibrio cholera*. Withanolide D has antifungal cytotoxic activity on thirteen fungi which is responsible for human infectious (five dermatophytes, one no dermatophyte mold, six yeasts, and *Pneumocystis carinii*) also demonstrated the

antioxidant and antimicrobial activities of various extracts of *W. Coagulans* fruits.<sup>[15]</sup>

## 4. Anti-Oxidant Activity

- There are several phytochemical constituents present in the methanol and aqueous extracts of *Withania coagulans*.
- These phytochemical constituents are responsible for antioxidant activity of the plant. The results are in accordance with the results of in vitro antioxidant activity as revealed by Fenton's reaction. Further studies on isolation and characterization of the specific constituent are needed to validate our results. The study thus can be further utilized to formulate the natural antioxidant which can be used as a dietary supplement to fight against several diseases such as ageing, atherosclerosis etc. which caused due to Reactive Oxygen Species (ROS).<sup>[16]</sup>

## 5. Anti-inflammatory activity

- The aqueous extract of fruits of *W. Coagulans* has significant anti-inflammatory activity at 10 mg kg<sup>-1</sup> in subacute models of inflammation, such as granuloma formation and formalin-induced arthritis in rats. *W. Coagulans* possesses efficient anti-inflammatory activity as compared with hydrocortisone, a common anti-inflammatory drug.<sup>[17]</sup>
- Oral administration of 1000 mg kg<sup>-1</sup> *W. Somniferous* root powder decreased the glycosaminoglycan content by 92%, which was much higher than that of the hydrocortisone and phenylbutazone. The Methanolic fractions of the extract showed high anti-inflammatory activity as compared to that of a 5 mg kg<sup>-1</sup> dose of hydrocortisone sodium succinate. The activity in both the species was attributed 5392.<sup>[18]</sup>
- Plants Res. To the high content of biologically active steroids in the plant, of which withaferin A is known to be a major component. Withaferin A is potent inhibitor of the pro inflammatory transcription factors and a promising agent for the treatment of the inflammatory cascade of cardiovascular diseases Anti-inflammatory activity of *Withania coagulans* extract was calculated from the absorbance against different concentration and percentage protein inhibition was found to be maximum 96% and minimum 62%.

## 6. Antibacterial and anthelmintic activities

- The volatile oil obtained from alcoholic extract of fruits of *W. coagulans* has antibacterial activity against *S. aureus* and *Vibrio cholera*, and it is also found to have anthelmintic activity.<sup>[19]</sup>

## 7. Anticancer and chemo protective activities

- The anticancer effect of *Withania* has been studied extensively and it was found that it is the most effective agent in preventing cancer through its ability to reduce the tumor size.
- Treatment of root extract of *W. Coagulans* on induced skin cancer in mice exhibited significant decrease in the incidence and average number of skin lesions compared to control group
- Withaferin A showed tumor-inhibitory activity against cells derived from human carcinoma of the nasopharynx and it also inhibited the growth of roots of *Allium cepa* by arresting the cell division at metaphase.
- The aqueous extract of *W. Coagulans* was used for anti-cytotoxic effect in chicken lymphocytes and remarkable inhibitory activity of Dimethyl Sulfoxide (DMSO)-induced cytotoxicity with a decrease in TNF-G production was reported.<sup>[26]</sup>

## 8. Immuno-Suppressive Effects

- Six new withanolides, withacoagulin A-F (1-6, resp.), together with ten known withanolides, 7-16, were isolated from the aerial parts of *W. coagulans*. These compounds, including the crude extracts of this herb, exhibited strong inhibitory activities on the T- and B-cell proliferation.<sup>[19]</sup>

## 9. Antifungal Activity:-

- The antifungal activity was evaluated using all 12 different fractions extracts of methanol and hexane and their mixtures using plant extract of *W. coagulans* against *A. Niger* and *C. albinos* by the disc method.<sup>[20]</sup>
- Plant extracts have shown a variety of potentials such as reducing, antioxidant, synthetic, and medicinal activities due to the presence of numerous bio-molecules that exist in different parts of the plant. Depending upon the nature each show different extents of variation in their capabilities due to the presence of some additional biomolecules and the varying concentrations of those

biomolecules. Considering *Withania*, it is truly rich in phenols, flavonoids, alkaloids, steroids and other complex structures that provide reducing, antibacterial and antifungal activities.

- Antifungal activity was exhibited against various strains such as *A. flavus*, *A. Niger*, *Penicillium* and *Alternaria alternate*, where a significant 6–10 mm zone was measured. the addition of solvents, mixtures of solvents, and the concentration help in simplifying the complex structure of the plant extracts that displayed much higher activities, including bio reduction, antibacterial and antifungal properties.<sup>[20]</sup>

## 10. Wound healing activity

- Aqueous–Methanolic phase of Methanolic extract of *W. coagulans* showed significant wound healing activity in open and incised wound model. It was also found to accelerated collagen, mucopolysaccharides, DNA and protein synthesis.<sup>[21]</sup>
- The hydroalcoholic fraction of the methanolic extract of *W. Coagulans* was administered in the form of 10% w/w ointment topically and at a dose of 500 mg/kg body weight orally to streptozotocin-induced diabetic rats. The hydroalcoholic fraction in both the forms, i.e., topical (10% w/w ointment) and oral (500 mg/kg body weight, p.o.) Showed a significant increase in the rate of wound contraction compared to diabetic controls.<sup>[19]</sup>

## ➤ Other Activities: -

- I. Moreover, the hepatoprotective effect of 3F-hydroxy-2, 3 dihydro-withanolide F obtained from fruit of *Withania coagulans* was studied against the CCl<sub>4</sub> induced hepatotoxicity in adult albino rats. The hepatoprotective effect of withanolides F was more active than hydrocortisone.
- ii. *Withania coagulans* has wound healing activities in Streptozotocin-induced diabetic rats. The hydro alcoholic fraction of the Methanolic extract (standardized by withaferin A) of *Withania coagulans* in both topical and oral form showed a significant 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.

- iii. The aqueous extract of *Withania coagulans* also exhibited free radical scavenging activity in an in vitro system using DPPH.
- Aqueous extract of fruits of *Withania coagulans* have antioxidant potential against several diseases such as ageing, atherosclerosis etc. which caused due to ROS.
- iv. The essential oil obtained by steam distillation of the petroleum ether extract of the fruits of *Withania coagulans* has shown anthelmintic activity
- The aerial parts of *Withania coagulans* have anthelmintic activity in ruminants. Also Khare reported an anthelmintic activity for *Withania coagulans*.
- 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 associated with the presence of the active principles of polar nature where withanolides are the main chemical protagonist of this activity. Investigation's supports using *Withania coagulans* as the diuretic agent in traditional folklore medicine.<sup>[27]</sup>

#### Phytochemical Screening and Determination of Antioxidant Potential of Fruits Extracts of *Withania coagulans*: -

- Preliminary Phytochemical Screening Standard screening tests of Methanolic and aqueous extracts were carried out for various plant constituents.<sup>[24]</sup>
- The crude extracts were screened for the presence or absence of secondary metabolites such as alkaloids, steroidal compounds, phenolic compounds, flavonoids, saponin, and tannins using standard procedures.<sup>[24]</sup>
- **Phytochemical screening of the extracts:** The results confirmed the presence of alkaloids, glycosides, steroids, saponin and oils in both the extracts of the fruit of the plant. Some of the constituents were observed in one or the other extracts.
- These phytochemical constituents are good source of antimicrobial and antioxidant activity. The results of phytochemical screening are reported in Table 3.1.
- In the present investigation it is revealed that there are several phytochemical constituents present in the methanol and aqueous extracts of *Withania coagulans*. These phytochemical constituents are responsible for antioxidant

activity of the plant. The study thus can be further utilized to formulate the natural antioxidant which can be used as a dietary supplement to fight against several diseases such as ageing, atherosclerosis etc. which caused due to Reactive Oxygen Species (ROS).<sup>[25]</sup>

- **Physio-chemical studies:** Physio-chemical parameters of the powdered drug such as total ash, acid insoluble ash, water soluble extractive value and alcohol soluble extractive value have been determined according to the procedures mentioned in Pharmacopoeia of India (1996).<sup>[25]</sup>

#### Marketed Formulation

##### 1. Tablets:

**Brand name:** Bakson

**Ingredients:** *Withania Coagulans* (paneer phool), PVPK30, Silicon dioxide, microcrystalline cellulose.

**Use:** For Diabetes which helps in maintaining glucose level.



Fig 3.2 *Withania coagulans* tablets

##### 2. Powder:

**Brand name:** YUVIKA, DKC Aggrotech

**Ingredients:** Paneerke Phool

**Use:** Yuvika Paneer Dodi Powder -*Withania Coagulans* is said to have sedative and diuretic properties. It is said to combat insomnia, nervous exhaustion, asthma and diabetes.



Fig 3.3 Berries powder

##### 3. Dried berries:-

**Brand:** Bixabotanical

**Ingredients:** Dried berries of *Withania coagulans*.

**Use:** By Maceration overnight, and drinking the Extraction empty stomach.



Fig 3.4. Dried Berries

### III. CONCLUSION

- The different part i.e. berries, leaves, root etc. of *Withania coagulans* possess variety of biological activity. It is an important medicinal herb as large numbers of phytochemicals (esterases, free amino acids, fatty oil, an essential oil, alkaloids and withanolides) have been isolated from this plant. Withanolides are steroidal lactones having significant pharmacological activities. In various studies it has been seen that the *Withania coagulans* possess several medicinal properties such as hepatoprotective, anti-inflammatory, Antihyperglycemic, free radical scavenging, hypolipidemic, antimicrobial, cardiovascular, central nervous system depressant, immunomodulating, antitumor and cytotoxic activities. In Further study on this plant to elucidate its effect on other diseases and mechanism of action in depth is need of hour. In the coming era, it could be consider as noble ayurvedic drug for the treatment of various ailments.

### IV. FUTURE PROSPECTIVE

- The use of *W. coagulans* as multipurpose traditional medicine has resulted into several commercial drugs and therefore *Withania* ranks a highly valued plant in the pharmaceutical industries. The photochemistry and pharmacology of *Withania* has been widely investigated, but the studies on toxicology of the extracts of the plant parts in different solvents are very few. In the case of *W. Somnifera*, the studies are at a primary level and there are no such reports on *W. coagulans*. Although it is required to identify the novel clinical properties of the plant, the identification and isolation of the particular compound responsible for the specific activity is more important. We believe that further advancements in the analytical and separation chemistry will provide valuable insights on the toxicology and isolation of novel compounds

along with the chemotypic variation of these two ethno botanically important species. The availability of micro propagation protocol will be supportive to conserve the elite germplasm of this genus. Further, the transgenic protocols for either the plants are well established but the efforts to enhance the withanolides or alkaloids content in plant parts using this approach are lacking. The progress in the transgenic biotechnology will further pave the way for metabolic engineering of useful compounds from *W. Somnifera* and *W. coagulans*.

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