

**REVIEW ON MEDHYA (INTELLECT PROMOTING) ACTION OF  
GUDUCHI [TINOSPORA CORDIFOLIA (WILD) MIERS]****Dr. Pansare T. A.\*<sup>1</sup>, Dodke Pranita<sup>2</sup> and Borokar Archana<sup>3</sup>**<sup>1</sup>Associate Professor of Dravyaguna Department, Government Ayurvedic College.

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Dravyaguna Department,  
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College. Osmanabad,  
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Even though enormous development has occurred in the field of psychiatry, the difficulties with management of a certain mental problems such as cognitive dysfunction, memory disorder, anxiety, mental retardation etc. have yet remained unsolved. Moreover adverse effects of anti-psychotic drugs are generating substantial amount of discomfort to the patients. Hence there is a need to discover suitable, safe and effective drug from plant origin. *Ayurveda* has the potential to tackle the problem of neurodegeneration and its effects on cognition and to improve the quality of life of a person. Medhya drugs are mentioned in Ayurvedic classical texts for enhancement of cognition and they act on psychological co-morbidities like agitation, stress and

depression. *Guduchi* (*Tinospora cordifolia* (Willd.) Hook. f. & Thomson) is one of the *medhya Rasayana* possessing multi-dimensional actions and having an influence on mental health. Its *Ushna Virya* and *Tikta Rasa* promotes *Sadhak Pitta* and enhances *Grahana* (grasping power) and *Smarana* (Memory). It encourages the organic metabolism by *Agnideepan* and *Dhatwagnideepan* action resulting in improved structural and functional form of *Majja Dhatu*. Furthermore its *Madhur Vipak* promotes *nourishment of the brain*. The analysis of literature in this regard exposed distinguished pharmacological activities of *Guduchi* like nootropic, antioxidant, anti-aging, free radical scavenging, anti-inflammatory, anti-stress, cognition, CNS depressant, anti-convulsant and anti-toxic activities. The present endeavour is to highlight data about *Ayurvedic* aspect and phytochemical and relevant pharmacological study for justification of Medhya activity of *Guduchi*.

**KEYWORDS:** *Guduchi*, *Tinospora cordifolia*, *Medhya*, intellect promoting.

## INTRODUCTION

The brain is the centre of the nervous system which controls memory, thought, reason judgment, consciousness and emotions. Supporting the brain health is imperative for ensuring a successful regulation and coordination of body activities. Cognitive decline associated with aging could be minor or major neuro-cognitive disorder presenting with progressive intellectual deterioration interfering with day to day activities. Behaviour and personality changes may complicate the life in due course. Significant increase in global prevalence of people aged above 60 years has raised concerns on effective management of old age problems about mental health. One comes across several diseases requiring treatment, diseases which are not only physical but also mental or psychological in nature. Neurological and psychiatric disorders are usually linked with loss of memory, cognitive deficits, impaired mental function etc. Mental illnesses are health conditions including changes in thinking, emotions or behavioural (or a blend of these). Mood disorders are generally related with extensive burden of disease, suicides, physical co-morbidities, lofty economic costs, and poor quality of life. Hence, it has become the most important public health problem nowadays.

Mental illnesses are related with distress and /or problems leading to improper performance in social work or family activities. World Health Organization estimated that mental and behavioural disorders account for about 12 percent of the global burden of diseases. The prevalence of mental disorders is 5.8 percent among the Indian population.<sup>[1]</sup> 2000, a review of epidemiological studies estimated that the prevalence of mental disorders in India was 70.5 per 1000 in rural and 73 per 1000 in the urban population.<sup>[2]</sup>

Mental health problems affect the affects person's personality, thought process and social interactions. Mental illness lead to various problems like somatic problems (migraines, loss of appetite, fatigue, insomnia), cognitive and emotional problems(anxiety, depression, guilt, fear, anger, confusion), and behavioural troubles(changes in attitude, social withdrawl). Mental illness can be extremely painful and traumatic time for all of the family and have huge impavt on a family's financial and emotional components. Unfortunately modern medicine based psychoactive drugs have got limited success in management of various neurological and psychiatric disorders because of multi-factorial nature of these diseases. *Ayurveda* may provide better solution for problems concerned with mind and body.

### Ayurvedic concept of Medha

Human being is considered as supreme and superior to other living beings.<sup>[3]</sup> “*Mananaath Manushyayah*” – The man has a capacity to remember the past and anticipate the future.<sup>[4]</sup> *Ayurveda* not only aims at maintenance of health and curing of diseased but also in harmonizing the complexity of body, mind and soul.<sup>[5]</sup> It is true that ‘intellectual strength is more important than just physical strength’. Learning manifests itself in memory through different events, experiences, people and objects.<sup>[6]</sup> In the present competitive world, for overall development of an individual there is need for promotion of mental health and also management of psychological problems.<sup>[7]</sup> *Ayurveda* categorizes diseases into two main types i.e. physical those affecting the body and mental or psychological those affecting the mind. The psychological diseases may prove more dangerous than physical illness and individual as well as community have to face the problems. *Ayurveda* provides a safe and lasting impact on child’s mental health, reducing stress and improving performance. Psychological health or a healthy state of mind depends on the sense organs and their functions like awareness, sharpness, focus and attention which leads to good memory and decisiveness.<sup>[8]</sup>

In *Charaka Samhita*, it has been stated that *Buddhi*, *Mati*, *Medha*, *Pradnya* have the same meaning. *Buddhi* is the discriminative psychological power for reasoning and logic. It is regarded as as decisive authority to distinguish between good-bad and thus act accordingly.

The term medha is used in two ways viz. *grahan shakti* (grasping) and *dhaaran shakti* (retention).<sup>[9]</sup>

The word *Buddhi* has originated from the Sanskrit word “*Budh Grahane*”. Applying suffix ‘Ktin’ to *Buddh Dhatu*, the word has been derived. It can be defined as a phenomenon by which knowledge is gained ‘*Budhyate Anena Iti Buddhi*’. *Chakrapani* has given the definition of *Buddhi* as - The word *Avasthanam* meaning centralization of the knowledge after grasping, *Sthiramativam* means retaining the knowledge for longer period and *Abibhramena* is the final stage of *Buddhi*, when no more doubts and confusions arise and the fact is crystal clear.<sup>[10]</sup>

*Dalhana* defined it as the intellectual capability to retain a huge amount of knowledge for a long time. It is considered as the utmost form of *buddhi* which acts at fine levels<sup>10</sup>.

*Arunadutta* has mentioned *medha* as faculty of *buddhi*. The word *Medha* is derived from the *Sanskrit* root '*Medhri Sangame*' i.e. to meet or to come together or harmonize. According to *Amarakosha*, '*Medhyate Sangachhate Sarvamiti*' i.e. to have proper co-relation and understanding about the knowledge of the existing objects. Without *Medha*, knowledge cannot be understood. According to *Chakrapani*, "*Dharanvati Dhi Medha*" which means *Dhi* is a type of *Medha* having the power of retention of knowledge. Recall of previous knowledge or experiences is *smriti*. The normal performance of *smriti* leads to *buddhi*. It is the remembrance of *drushta* (seen), *srushta* (heard) and *anubhoota* (experienced).<sup>[11]</sup> *Acharya Sarangadhara* has stated that, *medha* (grasping and retention powers) deteriorates after the fourth decade of life and this may be considered as a warning sign for further deterioration of *smriti* (memory) and *buddhi* (intellect) in the later years.<sup>[12]</sup>

### Relation Between Tridoshas and Medha

According to *Ayurveda*, there could be many causes for poor memory and IQ, the primary ones being malnutrition and imbalance of *Doshas* leading to improper brain functions. *Ayurveda* explains that the *Kapha Dosha* of the body is responsible for memory problems as vitiated *Kapha Dosha* leads to a dull mind or disinterestedness. Similarly, vitiated *Vata Dosha* also leads to stress and confusion, leading to the obstruction of knowledge and memory. *Vata Dosha* is responsible for all nervous functions and memory. So, in order to improve your memory, both *Vata* and *Kapha Dosha* should be balanced. A combination of *Vata* and *Kapha* improves the memory. *Pitta Dosha* plays a major role in improving sharpness and IQ.<sup>[13]</sup>

**Vata:** *Prana* *vayu* is responsible for controlling the functions of *Buddhi* and *Mana* (*buddhi citta indriya dhrik*), while *udana* *vayu* helps in recalling the past experiences.<sup>[14]</sup>

**Pitta:** Function of *Pitta* is to promote *medha*,<sup>[15]</sup> but *sadhaka pitta* is mainly responsible for good *medha*, *Buddhi* and *abhimana*.<sup>[16]</sup>

**Kapha:** *Tarpaka* and *avalambaka kapha* in their normal state provide the knowledge and intelligence. *Kapha* is also responsible for the best qualities of *dhruti*.<sup>[17]</sup>

### Medhya Rasayan

The concept of "*Medhya Rasayana*" is one such area which involves consideration and application in current scenario. *Ayurvedais* exploring wonderful benefits from the herbs

which are used in diverse aspects and one of the aspects comprises brain function which includes improving memory, alertness, concentration, intelligence and mental performance. *Ayurveda* and other ancient Indian literature illustrate the use of plants in prevention and treatment of diseases of mankind since the time immemorial. Plants are used in traditional herbal medicines, which are being acknowledged in today's society as a significant source of health due to their extensive range of benefits including low cost of production, higher safety margins, non-toxic property and least risk of side effects.<sup>[18,19]</sup>

The '*medhya rasayanas*' are recognized for improving the intellectual. They include Juice of *Centellaasiatica* Linn (*Mandukparni swaras*), powder of *Glycyrrhiza glabra* Linn. with milk (*Yashtimadhu churna* with *ksheer*), juice of *Tinospora cordifolia* Willd Miers ex Hook f. (*Guduchi swaras*) and paste of *Convolvulus pluricaulis* Chois (*Shankhapushpi kalka*)<sup>[20]</sup> They are used for prevention of psychological disorders and enrichment of mental powers of all the age groups. They promote the Intellect (*Dhi*), Retention power (*Dhriti*), memory (*Smriti*). They act as brain tonics or rejuvenators.

The word '*Medhya Rasayanas*', have been derived from the *Sanskrit* words '*Medha*', meaning intellect, and '*Rasayana*', refers to rejuvenation. These herbs acting on the brain are called as Nootropic herbs which improve higher integrative brain functions such as memory, learning, thinking and understanding (Nootropic is derived from Greek and means acting on the mind) and their isolated constituents referred to as smart drugs.<sup>[21]</sup> Nootropics also regarded as memory enhancers, neuro enhancers, cognitive enhancers, and intelligence enhancers and smart drugs which are the drugs, supplements, nutraceuticals, and functional foods that purportedly improve mental functions like cognition, memory, intelligence, motivation, attention, and concentration.<sup>[22]</sup>

*Medhya rasayanas* have particular effect on mental performance by promoting the functions of 'Buddhi' and 'Manas' by correcting the disorders of 'Rajas' and 'Tamas'.<sup>[23]</sup> Actually they generate Neuronutrient effect by improving cerebral metabolism. *Medhya Rasayanas* have claimed to improve cognitive functions of the brain and help in regeneration of neural tissues besides producing anti-stress, adaptogenic and memory enhancing effect, and retarding brain aging. Earlier reports point out that pharmaceutical drugs are deficient in providing such benefits which are offered by *Medhya Rasayanas* plants.<sup>[24]</sup> These drugs help the person to attain sedation, calmness, tranquillity or a stimulation of activities of brain.<sup>[25]</sup>

### Ayurvedic information of Guduchi

According to Acharya Charaka *Guduchi* is one of the powerful medhya rasayana. Its Hindi name *giloya* refers to a heavenly elixir used to stay off the aging and to stay young forever. The Sanskrit name *Guduchi* means one that protects the body from illnesses. *Tinospora cordifolia* (Willd.) Hook. f. & Thomson, is also called 'a magical herb' owing to its property of curing a lot of maladies. Among many vernacular names, the most striking one is 'AMRITA', which is attributed to this wonder-drug for its ability to offer everlasting youthfulness, strength and longevity to its patron.

*Guduchi* [*Tinospora cordifolia* (Willd) Miers] belonging to family Menispermaceae; distributed throughout most parts of India, Burma, Andamans & Ceylon. *Guduchi* is very much useful to enhance memory.<sup>[26]</sup> It rejuvenates the nervous functions. It is also a natural tonic for mental development of children. Its use improves the balance and is useful in vitiation of Tridoshas i.e. Kapha-vata-pitta doshas. *Guduchi* is one drug which has undergone numerous experimentation for its therapeutic utility. It has shown positive activity over different system. Traditionally, it has been used as an anti-spasmodic, anti-inflammatory, jaundice, diabetes, seminal weakness, urinary tract infections, fever, and general debility, skin diseases, expectorant, carminative, digestive, anti-stress and aphrodisiac.<sup>[27]</sup> The root of *Guduchi* is known for its anti-stress, anti-leprotic and anti-malarial activities.<sup>[28,29]</sup>

### Vernaculr Names<sup>[30]</sup>

**Assamese:** Siddhilata, Amaralata, **Bengali:** Gulancha, **Gujarati:** Galac, Garo **Hindi :** Giloe, Gurcha, **Kannada:**Amrutaballi, **Kashmiri:**Amrita, Gilo, **Malayalam:** Chittamrutu **Marathi:** Gulvel, **Oriya:**Guluchi, **Punjabi:**Gilo, **Tamil:**Seendal, **Telugu:**Thippateega, **Urdu :** Gilo.

### Synonyms Name<sup>[31]</sup>

*Guduchi*, Madhuparni, Amruta, Chhinruha, Vstyadini, Tantrika, Kundlini, Chakralakshika.

### Rasapanchaka of *Tinospora Cordifolia*<sup>[32]</sup>

Rasa- *Tikta, Katu, Kashaya*

Virya-*Ushana*

Vipaka-*Madhur*

Guna- *Laghu*

Doshghnta- *Tridoshshamak*

### Mode of Medhya Action of Guduchi According To Ayurveda

*Tikta, Katu, Kashaya* rasas are katabolic in effect and have absorbing effect and deplete *Kleda*. *Tikta rasa* absorbs *kleda* due to *vayu mahabhoota* and helps in vacating space because of *akasha mahabhoota*. Moreover on account of *sukshma Guna* it permeates even to the minute channels and helps the drug to reach at cellular level. Thus it activates microcirculation and improves tissue perfusions. The intellect and all conscious manifestations are attributed to the *Satva-guna*. The *akasha, mahabhoota* possessing the *Satva guna* predominance are mainly responsible for the promotion and nourishment of *medha*. *Katu rasa* acts in similar way by absorbing fluids and expel the obstructive material due to predominance of *vayu* and *Agni mahabhootas*, thus cleans the channels and hence it is responsible for alleviating *Tama dosha* of *mana*. *Kashay Rasa* also helps to absorb *kleda*. *Tikta* and *Katu rasa* repairs altered *Jatharagni* and *Majjadhatvagni*. The both *Rasas* perform the function of *srotoshodha* (Channel cleaning.) *i.e.* they clean the channels by *Aampachan* *i.e.* detoxifying the metabolic waste and support the nourishment of *Dhatu*s.

### Ushna Veerya

It stimulates *Agni* which *is the part and parcel of all bio-transformations in the body*.

Subsequently it corrects the *Dhatvagnimandya* and thus encourages the organic metabolism by *Agnideepan* and *Majjadhatwagnideepan* action resulting in improved structural & functional form of *Majja Dhatu*.

It alleviates *Vata* which is the predominant *Dosha* in an old age. *Ushna Veerya* promotes the *pitta* viz. *Sadhak pitta* and enhances *Grahana* and *smarana shakti*. (***i.e., grasping power and Memory***). *Shivdasa* in his commentary has mentioned that *Veerya* is the potency which is sited in a specific fraction of the drug where the potency lies in concentrated form. This, more or less synchronises with the modern concept of active chemical fractions of the drug which are accountable for action.

### Madhur Vipaka

*Madhur Vipaka*, which is responsible for the *brihana* (quantitative growth) of *rasadi dhatu*s and thus enriches the nutritional value of *Majjadhatu*.



It also plays an important role in the Vata Shaman. Madhurvipak increase the kapha in general and Tarpaka and Avalambaka kapha in particular, which nourish the dhi, dhrti, smrti and medha.

### Laghu Guna

*Guduchi* possessing Laghu guna have Satva guna dominance of varying degree. The drugs of laghu, usna guna stimulate the pitta in general and stimulate sadhakagni which in turn generates medha.<sup>[33,34]</sup>

The plant is also documented to possess beneficial effects such as *Deepan* (appetizer), *Rasayana* (rejuvenating) and *Medhya* (brain tonic). By the virtues of *Agnideepan* (stimulating *Agni*), *Aampachan* (digesting *Aam*) and *Srotas-shodhana i.e.* cleaning the channels by detoxifying the metabolic waste, it supports the nourishment of *Dhatu*s and mind as well as boosts energy. It performs the functions of *Dhatwagnideepan* in addition to *Dhatwagniposhan* and helps to improve physical and mental health. It increase *Agni* at all levels and it reduces *Ama* and corrects *Majjadhatvagnimandya* (*hypofunctioning of majjadhatu*). It improves the quality of '*Rasa*' and strengthen the health of all other successive *dhatu*s (tissues) of the body as these *Dhatu*s develop consecutively. *Rasayana* acts at the level of *Rasa*, *Agni* and the *Srotas*, therefore enables the organism to procure the most excellent qualities of different *Dhatu*s. Due to Rasayan action of *Guduchi*, it helps to attain better nutritional status and the creation and development of viable cells and tissues that help to prolong aging. Rasayan plant is useful in management of diseases *viz.* degenerative, autoimmune and metabolic diseases and mainly aging.

As Tikta, Kashya, Rasa, and Madhur Vipaka & Ushna Virya helps to improve Satva Guna of Mana.<sup>[35,36]</sup>, *Guduchi* performs Medhya action.

### Modern aspect of Guduchi

#### Taxonomical Classification<sup>[37]</sup>

Kingdom-Plantae; Division-Magnoliophyta; Class-Magnoliopsida; Order -Ranunculales; Family - Menispermaceae; Genus -Tinospora; Species- T.Cordifolia.

### Chemical Constituents

A large number of chemicals have been isolated from *T. cordifolia*, belonging to different classes such as alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoid,



phenolics, aliphatic compounds and polysaccharides. Leaves of this plant are rich in protein (11.2%), calcium and phosphorus.<sup>[38]</sup> Four new clerodane furano diterpene glucosides (amritosides A, B, C and D) have been isolated as their acetates from stems. The structures of these compounds were established on the basis of spectroscopic studies.<sup>[39]</sup> The glycosylated component of a polysaccharide from *T. cordifolia* has been isolated, purified, methylated, hydrolyzed, reduced and acetylated. The partially methylated alditol acetate (PMAA) derivative thus obtained has been subjected to Gas Chromatography-Mass Spectrometry (GC-MS) studies. The following types of linkages were reported: terminal-glucose, 4-xylose, 4-glucose, 4, 6-glucose and 2, 3, 4, 6-glucose.<sup>[40,41]</sup> Callus and cell suspension cultures have been established from the stem explants of the plant. Accumulation of berberine and jatrorrhizine (protoberberine alkaloids) was observed in both callus and cell suspension cultures.<sup>[42]</sup> The signaling mechanism of the novel (1, 4)-alpha-D-glucan (RR1) isolated from *T. cordifolia* was investigated in macrophages to evaluate its immuno stimulating properties.<sup>[43]</sup> An arabinogalactan has been isolated from the dried stems and examined by methylation analysis, partial hydrolysis and carboxyl reduction. Purified polysaccharide showed polyclonal mitogenic activity against B-cells; their proliferation did not require macrophages.<sup>[44]</sup> Detailed chemical constitution of *T. cordifolia* is given in<sup>[45]</sup> Phytochemical characterization includes a test for one of the Phytochemical components, namely, tinosporaside (limits, 0.03% to 0.04%).<sup>[46,47]</sup>

### **Mode of intellect promoting action of Guduchi according to modern science**

*Tinospora cordifolia* has been claimed to possess learning and memory enhancing,<sup>[48]</sup> antioxidant,<sup>[49,50]</sup> and anti-stress activity.<sup>[51]</sup> Increases verbal learning and memory and logical memory (of immediate and short term type), enhances cognition (learning and memory) in normal rats and cyclosporine induced memory deficit, anti-stress, anti-depressant and anxiolytic properties, improvement in sensile memory impairment. The major constituent of *Guduchi* is berberine which exhibits a peculiar action. It is isoquinolone alkaloid that has AChE (acetylcholinesterase inhibitory) action. Similarly it is MAO – inhibitory. Berberine helps prevent oxidation damage to bio molecules of brain, reduces peptides that interfere with memory function and lowers lipids that hamper cerebral blood flow.<sup>[52]</sup> Thus, *Guduchi* arrests neuro degeneration which is commonly present in Alzheimer's disease. Berberine reduces a beta levels by modulating APP (amyloid precursors) processing in human neuroglioma cells without toxicity Hence it used as medhya rasayana in degenerative disorders. Neuroprotective and ameliorative properties are due to their antioxidant and trace element contents. *Tinospora*

cordifolia is known to be a rich source of trace elements (Zinc and Copper) which act as antioxidants and protects cells from damaging.<sup>[53]</sup>

Strong free radical scavenging properties against reactive oxygen and nitrogen species diminishing the expression of iNOS gene, reduction in thiobarbituric acid reactive substances and an increase in reduced glutathione catalase and superoxide dismutase (anti-oxidant).

The neuroprotective activity of ethanol extract of *Tinospora cordifolia* aerial parts have been shown in a study involving 6-hydroxy dopamine (6-OHDA) lesion rat model of Parkinson's disease (PD).<sup>[54]</sup> Evidence also exists for aqueous ethanolic extract of *Tinospora cordifolia* playing a role for differentiation based therapy of glioblastomas. Involvement of Monoaminergic and GABAergic Systems in Antidepressant-like Activity of *Tinospora cordifolia* is shown in a study involving mouse model of depression using tail suspension test and forced swim test.<sup>[55]</sup> Another study showed the neuroprotective activity of *Tinospora cordifolia* involves modulation of the antioxidant system in rat hippocampal slices subjected to oxygen glucose deprivation.<sup>[56]</sup> *Tinospora cordifolia* may also play an effective role against ischemic brain damage as it attenuate oxidative stress mediated cell injury during oxygen-glucose deprivation (OGD) in rat hippocampal slices.<sup>[56]</sup>

Chemical constituents' classes are alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoid, phenolics, aliphatic compounds and polysaccharides.<sup>[57]</sup> Neuroprotective and ameliorative properties are due to their antioxidant and trace element contents.<sup>[50]</sup> *Tinospora cordifolia* is known to be a rich source of trace elements (Zinc and Copper) which act as antioxidants and protects cells from the damaging effects of oxygen radicals generated during immune activation.<sup>[59]</sup> It increases the blood profile and has lead scavenging activity.<sup>[60]</sup>

## **Pharmacological activities**

### **Neuroprotective or Nootropic**

Alcoholic and aqueous extracts of the whole plant of *Tinospora cordifolia* was administered orally for 15 days in two groups of rats. Cyclosporine 15, 25 mg/kg, *i.p.* was administered on alternate days for 10 days. Combination of cyclosporine 25 mg/kg, *i.p.* for 10 days and Tc alcoholic 200 mg/kg and Tc aqueous 100 mg/kg were administered in two different groups of rats. At the end of treatment, learning and memory was assessed using Hebb William maze and passive avoidance task. The locomotor activity was assessed using open field chamber. The immune status was studied using DNCB skin sensitivity test. Histopathological

examination of hippocampus was done. Both alcoholic and aqueous extracts of Tc produced a decrease in learning scores in Hebb William maze and retention memory indicating enhancement of learning and memory. However, cyclosporine at both the doses increased the learning scores in Hebb William maze and decrease in retention time in the passive avoidance task suggesting a memory deficit. The combination of cyclosporine and Tc produced a decrease in learning scores in Hebb William maze and increase latency in passive avoidance task compared to cyclosporine alone treated rats. The histopathological examination of hippocampus in cyclosporine treated rats showed neurodegenerative changes which were protected by the Tc.<sup>[61]</sup> The neuroprotective activity of ethanol extract of *Tinospora cordifolia* aerial parts have been shown in a study involving 6-hydroxy dopamine (6-OHDA) lesion rat model of Parkinson's disease (PD).<sup>[62]</sup> Evidence also exists for aqueous ethanolic extract of *Tinospora cordifolia* playing a role for differentiation based therapy of glioblastomas.<sup>[63]</sup> Involvement of Monoaminergic and GABAergic Systems in Antidepressant-like Activity of *Tinospora cordifolia* is shown in a study involving mouse model of depression using tail suspension test and forced swim test.<sup>[64]</sup> Another study showed the neuroprotective activity of *Tinospora cordifolia* involves modulation of the antioxidant system in rat hippocampal slices subjected to oxygen glucose deprivation.<sup>[65]</sup> *Tinospora cordifolia* may also play an effective role against ischemic brain damage as it attenuate oxidative stress mediated cell injury during oxygen-glucose deprivation (OGD) in rat hippocampal slices.<sup>[66]</sup>

### Anti-oxidation

*T. cordifolia* is mentioned as *vishaghnī*, *vishahara* and *tridoshashamaka* in various texts of *Ayurveda*. A significant increase in the concentration of thiobarbituric acid-reactive substances (TBARS) in brain, along with its decrease in heart, was observed in diabetic rats. *Tinospora cordifolia* treatment decreased the concentrations of glutathione reductase (GSH) and decreased activities of superoxide dismutase (SOD), catalase and glutathione peroxidase (GPx) in the tissues of diabetics rats. Alcoholic extract of the root of *T. cordifolia* (TCREt) administered at a dose of 100 mg/kg orally to diabetic rats for 6 weeks normalized the antioxidant status of heart and brain. The effect of *T. cordifolia* root extract was better than glibenclamide (600 µ/kg) although Insulin (6 units/kg) restored all the parameters to normal status.<sup>[67,68]</sup> *T. cordifolia* has also been reported to elevate GSH levels, expression of the gamma-glutamylcysteine ligase and Cu-Zn SOD genes. The herb also exhibited strong free radical-scavenging properties against reactive oxygen and nitrogen species as studied by electron paramagnetic resonance spectroscopy.<sup>[69]</sup> Aqueous extract of *T. cordifolia* inhibited

Fenton (FeSO<sub>4</sub>) reaction and radiation - mediated 2-deoxyribose degradation in a dose-dependent fashion, with an IC<sub>50</sub> value of 700 µ/mL for both Fenton and radiation-mediated 2-DR degradation. Similarly, it showed a moderate but dose-dependent inhibition of chemically generated superoxide anion at 500 µ/mL concentration and above, with an IC<sub>50</sub> value of 2000 µ/mL.<sup>[70]</sup> In various studies, *T. cordifolia* was found effective in iron-mediated lipid damage and gamma-ray-induced protein damage,<sup>[71]</sup> amelioration of cyclophosphamide-induced toxicity,<sup>[72]</sup> alteration of lethal effects of gamma rays,<sup>[73]</sup> induction of enzymes of carcinogen/drug metabolism and inhibition of lipid peroxidation in mice,<sup>[74]</sup> free radical generation and lipid peroxidation during oxygen-glucose deprivation,<sup>[75]</sup> and nitric oxide scavenging effects.<sup>[76]</sup> The extract of *T. cordifolia* has demonstrated antioxidant action in the alloxan induced diabetes model as well.<sup>[77]</sup>

### Anti aging

*Guduchi* (*Tinospora cordifolia*). The aqueous extract of the root contains Alkaloids (berberine, palmatine, magnoflorine, tinosporin, isocolumbin), glycosides steroids, Phenolic compounds, Polysaccharides. Leaves of this plant are rich in protein (11.2%) and are fairly rich in calcium and phosphorus. It has been found to possess strong free radical scavenging properties against reactive oxygen and nitrogen species diminishing the expression of iNOS gene (their high levels create an opportunity to react with superoxide leading to cell toxicity). Significant reduction in thiobarbituric acid reactive substances and an increase in reduced glutathione catalase and superoxide dismutase (anti-oxidant) activity were also observed. It has shown to increase Monoamine oxidase (MAO-A and MAO-B) activities, the elevated levels of which have increased levels of brain monoamines leading to significant anti-depressant activity.<sup>[78]</sup>

### Free radical scavenging activity

To evaluate the antiradical activity of methanolic *Tinospora cordifolia* stem exhibited DPPH radical scavenging activity in concentration dependant manner. This method is based on the reduction of methanolic DPPH solution in the presence of hydrogen donating antioxidant (AH) due to the formation of non-radical form DPPH. The sensitivity of the method is determined by the strong absorption of DPPH.<sup>[79]</sup>

### Anti-inflammatory activity

The water extract of the stem of *Tinospora cordifolia* has been checked for anti-inflammatory activity in albino rats. It has significantly inhibited acute inflammatory response evoked by carrageenin when administered orally and intraperitoneally.<sup>[80]</sup>

### Anti-stress

*T. cordifolia* is known as a *medhya rasayana* (learning and memory enhancer) in *Ayurveda*. It is also described to be useful for treatment of *bhrama* (Vertigo) in various Ayurvedic texts. Significant response has been found in children with moderate degree of behaviour disorders and mental deficit, along with improvement in IQ levels.<sup>[81]</sup>

The root of *T. cordifolia* is known to be used traditionally for its anti-stress activity.<sup>[82]</sup> In a 21-day randomized, double-blind placebo-controlled study, the pure aqueous extract of the root was found to enhance verbal learning and logical memory.<sup>[83]</sup> *T. cordifolia* has also been shown to enhance cognition (learning and memory) in normal rats and reverse cyclosporine-induced memory deficit. Both the alcoholic and aqueous extracts of *T. cordifolia* produced a decrease in learning scores in Hebb William maze and retention memory, indicating enhancement of learning and memory. The histopathological examination of hippocampus in cyclosporine-treated rats showed neurodegenerative changes, which were protected by *T. cordifolia*.<sup>[84]</sup> Various extracts of the *T. cordifolia* exhibited comparable anti-stress activity in mice.<sup>[85,86]</sup>

### Cognition (Learning and Memory) Activity

*T. cordifolia* extract effects on learning and memory in normal and cyclosporine induced memory deficit rats. Alcoholic and aqueous extracts of the wholeplant of *T. cordifolia* was administered orally for 15 days in two groups of rats. Both alcoholic and aqueous extracts of TC produced a decrease in learning scores in Hebb William maze and retention memory indicating enhancement of learning and memory. *Tinospora cordifolia* enhanced the cognition in normal and cognition deficits animals in behavioural test Hebb William maze and the passive avoidance *Guduchi* has been shown to enhance cognition(learning and memory) in normal rats and reversecyclosporine-induced memory deficit. Alcoholic and aqueousextracts of *Tinospora cordifolia* have been shown to produce adecrease in learning scores in Hebb William maze andretention memory, indicating enhancement of learning and Memory.<sup>[87]</sup> *T. cordifolia* has also been shown to be beneficial in improving cerebral ischemia by possible mechanisms of preventing oxidative stress injury and cytokine

regulation.<sup>[88]</sup> Studies have shown that herbal formulations having the properties that can improve memory and function as a brain tonic, one such synergistic formulation is comprised of alcoholic extracts/juice of stems of *Tinospora cordifolia*, leaves of *Centella asiatica*, roots of *Withania somnifera*, seeds of *Mucuna pruriens* plus the rhizomes of *Curcuma longa*, mixed in the ratio ranging from 1:0.5:1:1:2 and 1:1:1:1:2 by weight balance. These substances were found to produce enhancement in the catalase, superoxide dismutase and glutathione peroxidase in frontal cortex as well as striatum of rats.<sup>[89]</sup>

### **CNS depressant activity**

Effect on locomotor activity Most of the drugs acting on central nervous system influence locomotor activity in man and animals. The CNS depressant drugs such as barbiturates, alcohol and tranquillizers like chlorpromazine reduce the locomotor activity while, the CNS stimulants such as caffeine and amphetamines increase the activity. In other words, the locomotor activity can be an index of wakefulness (alertness) of mental activity. The locomotor activity can be studied using Actophotometer, which operates on photoelectric cells, connected in circuit with a counter. Among the different solvent extracts evaluated during our study, petroleum ether, ethanol extracts of *T. cordifolia* leaf, stem and root showed significant reduction in locomotor activity after 2 hours of oral administration. Whereas the aqueous extract of leaf and root also showed significant reduction in locomotor activity after 2 hours. However, the animal group administered with aqueous extract of *T. cordifolia* stem the percentage decrease of locomotor activity was negligible.<sup>[90]</sup>

### **Anticonvulsant activity**

The anticonvulsant activity was accessed by determining and comparing the test group with that of the standard drug treated group. The petroleum ether extract having the % inhibition of extension phase is 35.3% and the ethanolic extract having % inhibition phase of 61.1%. The ethanolic extract treated animals was found to be significantly good activity compared to standard drug treated cases (Murthy *et al.*, 2012).

### **Anti-toxic Activity**

The gold standard drug for the treatment of Parkinson's disease is L-DOPA, but various studies have proved that the treatment with L-DOPA leads to the death of surviving dopaminergic neurons in the CNS. The coadministration of *Tinospora cordifolia* crude powder protected the dopaminergic neurons when compared with Sham operated control group. The treatment with *Tinospora cordifolia* crude powder could reduce the toxicities of

L-DOPA therapy for Parkinson's disease.<sup>[91]</sup> *Tinospora cordifolia* alkaloids such as choline, tinosporine, isocolumbin, palmetine, tetrahydropalmatine and magnoflorine showed protection against aflatoxin induced nephrotoxicity. *Tinospora cordifolia* extracts have been reported to scavenge free radicals generated during aflatoxicosis. It exhibited protective effects by lowering thiobarbituric acid reactive substances (TBARS) levels and enhancing the GSH, ascorbic acid, protein, and the activities of anti-oxidant enzymes viz., SOD, CAT, GPx, Glutathione S-transferase (GST) and glutathione reductase (GR) in kidney.<sup>[92]</sup> Cyclophosphamide an anti-cancer drug has been reported to reduce the glutathione content in both bladder and liver and lowered levels of cytokines Interferon- $\gamma$  and IL-2 an increased levels of pro-inflammatory cytokine TNF- $\alpha$ . This effect could be reversed on *Tinospora cordifolia* treatment indicating the role of *Tinospora cordifolia* in overcoming Cyclophosphamide induced toxicities in cancer treatment. Leaf and stem extract of *T. cordifolia* has been reported to show hepatoprotective effect in male albino mice against lead nitrate induced toxicity. Similarly, oral dose of plant extract prohibited the lead nitrate induced liver damage.

## CONCLUSION

It is an endeavour to highlight the medhyaaction of *Guduchi* on the basis of *Ayurvedic* as well as modern scientific aspect. The *Rasapanchaka* of *Guduchi* help it to conduct *Agnideepan*, *Aampachan* and *srotas-shodhana* actions i.e. it stimulates *Agni*, digests *Aam* and cleans the channels by detoxifying the metabolic waste and supports the nourishment of *Dhatus* moreover mind and makes the body more energetic. *Guduchi* performs the functions of *Dhatwagnideepan* as well as *Dhatwagniposhan* and improves physical along with mental health. Consequently it guards against degeneration, prolong youth and delays aging. Its *Ushna Virya* and *Tikta Rasa* stimulates *Sadhak Pitta* and enhances *Grahana* (grasping power) and *Smarana* (Memory) while its *Madhur Vipak* promotes nourishment of the brain. The observations and interpretation of phyto-chemical and pharmacological study of this plant validate the submissions made in the *Ayurvedic* classics regarding its Medhya i.e. intellect promoting action. This herb merits advance research as it may be a source of potential drug to treat neurological and psychiatric disorders generally related with loss of memory, cognitive deficits, impaired mental function etc.



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