



Review Article

A CRITICAL REVIEW OF ROLE OF MEDHYA DRAVYAS (NOOTROPIC DRUGS) IN BRAIN FOG WITH SPECIAL REFERENCE TO COVID- 19

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ABSTRACT

Cognitive dysfunction after COVID-19 are hypoxia, microvascular injury, immunological dysregulation, chronic inflammation, patients with mild infections also report cognitive symptoms. A recognized symptom of long COVID is “Brain Fog”, characterized by fatigue, lack of ability to concentrate and can severely affect memory and cognition. Long-term side effects of COVID-19 is Brain fog which occurs irrespective of the severity of the infection. The *Medhya Dravyas* (Nootropic drugs) are beneficial to improve the power of retention, grasping, discrimination and recollection thus improving the *Medha* (Cognition). Present clinical study is an attempt to evaluate the nootropic effect of certain drugs in Brain Fog with special reference to Covid 19. **Aim:** To review medicinal plants showing *Medhya Karma* (Nootropic activity) on signs and symptoms correlated with brain fog in Covid 19 with Ayurveda as a natural and safe remedy. **Material and Methods:** Materials related to Covid 19, Brain fog, Neurological symptoms cognitive impairment, *Medhya Dravyas* (Nootropic drugs) have been collected from different journals, *Ayurveda* and Modern text, Authentic websites (PubMed, Google scholar, Scopus, etc.), **Observation and Results:** Plants reviewed showed nootropic action by Antioxidant, Acetylcholine esterase inhibition, NMDA antagonism, Dopaminergic, Anti-amyloidogenic, Inhibition of Tau aggregation and Neuroprotection. These properties helps in the management of cognitive impairment. **Conclusion-Medhya Dravyas** possess nootropic and rejuvenative properties. Plants shown maximum inhibitory activities against the factors causing brain Fog by Neuroprotection and memory enhancement. It reveals the strength of the *Ayurveda* system as well as potential in developing new drug for memory enhancement.

INTRODUCTION

World is currently going through COVID-19 pandemic. In SARS-CoV-2 respiratory tract infections and involvement of nervous system with multi-organ disease is seen. In SARS-CoV-2 insomnia, malaise, myalgia, headache, cognitive imbalance, depression with anxiety neuropsychiatric symptoms are common.^[1] Chronic symptoms like general debility, cognition related issues and emotional instability have been described.^[2,3] Common post-acute manifestations are included by terms of post-COVID-19 syndrome or

long-COVID-19.^{[4],[5]} Cognitive impairment or brain fog is commonly found in long COVID cases. In long Covid cases other symptoms include difficulty in taste and smell perception, exhaustion, difficulty in breathing, sleep related issues, headache, cough, according to the Centers for Disease Control and Prevention (CDC).

Brain fog is brain activity gets sluggish or fuzzy. In Brain Fog person feels confused, difficulty in focusing on work, cannot recall the events or words, thinking process takes too much of time and loss of memory is seen.

In the acute phase of Covid 19 these neurological symptoms are frequently found.^[6,7] Possible theory for cognitive impairments due to COVID-19 can be associated with. Hypoxia or vascular damage in patients who suffered severe acute infections needed intensive care and/or respiratory support,^[8] another theory of microvascular injury due

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to dysfunction of endothelium is put forth.^[9] Apart from this patients with mild infections also report cognitive symptoms.^[10] Also abnormal immunological response, chronic inflammation, or malfunctioning of peripheral organs can lead to cognitive impairments.^[11] COVID-19 infection and its effect on neurodegeneration is currently under question.^[12] Cases of unmasking an underlying Parkinson's disease after COVID-19 which was previously in a preclinical stage is found.^[13,14]

Brain fog: Clouding of consciousness^[15] is known as brain fog. Person feels slightly less wakeful and unable to pay attention and inattentive of actuality. Sufferers describe this subjective discomfort as their mind status being "foggy".

Causes of Brain fog: Pregnancy, multiple sclerosis, medications, cancer and cancer treatment, menopause /hormonal changes, chronic fatigue syndrome, depression, lack of sleep, lupus, stress, fibromyalgia, diabetes, Sjogren syndrome, migraine, alzheimer. Long COVID can cause "brain fog", which is consisting of symptoms like fatigue inability to concentrate and impaired memory and cognition.^[16,17]

AIM

To review medicinal plants showing *Medhya Karma* (Nootropic activity) on signs and symptoms correlated with brain fog in Covid 19 with Ayurveda as a natural and safe remedy.

MATERIAL AND METHODS: Extensive compilation and tabulation related to Covid 19, Brain fog, Neurological symptoms cognitive impairment, *Medhya Dravyas* (Nootropic activity) were done by literary

search from different journals, Ayurveda and Modern text, Authentic websites (PubMed, Google Scholar, Scopus, etc.)

The plants for review were selected by authors on the basis of extensive review of scientific and Ayurveda literature. A total of 12 enlisted plants analyzed and discussed on the basis of *Rasa* (taste), *Vipaka* (post digestive effect/metabolite), *Veerya* (potency) and *Gunas* (properties) and *Doshghnata* (pacified *Dosha*) and pharmacological actions. Their therapeutic efficacy as anti-oxidant, acetylcholine esterase inhibition, anti-amyloidogenic/ reduction of B amyloid, antidepressant activity, antiparkinson activity, anxiolytic activity, cognitive enhancement, dopaminergic activity, inhibition of Tau aggregation, memory enhancing mood elevating effect, neuritic regeneration, neuroprotection, NMDA antagonism, sedative and anticonvulsant properties, synaptic reconstruction activity. These plants possess phytochemicals which has definite role in neurological disorders and act on *Dhee* (power of acquisition), *Dhruti* (power of retention), *Smruti* (power of recollection), *Sandhya* (consciousness), *Nidra* (sleep) related symptoms with relation to brain fog in Covid 19 related symptoms.

OBSERVATIONS

Following drugs has vital role in Neurological disorders and act on *Dhee* (power of acquisition), *Dhruti* (power of retention), *Smruti* (power of recollection), *Sandhya* (consciousness), *Nidra* (sleep) impaired symptoms with relation to Brain fog in Covid 19.

Table 1: Properties of reviewed medicinal plants as per Ayurveda

Plant	Properties	Karma	Action on Dosha
Brahmi ^[18] (<i>Bacopa monnieri</i> Linn)	<i>Rasa- Tikta</i> (bitter), <i>Kashay</i> (Astringent) <i>Vipaka- Madhur</i> (undergoes sweet taste conversion after digestion) <i>Veerya- Sheeta</i> (Cold potency) <i>Prabhav- Medhya</i> (Nootropic activity) <i>Guna- Laghu</i> (light)	<i>Shothahara</i> (anti-inflammatory activity), <i>Jvarahara</i> (antipyretic activity), <i>Pandughna</i> (anti-anemic activity), <i>Swarya</i> (Reduces hoarseness of voice), <i>Smrutiprada</i> , (improves power of recollection) <i>Mehaghna</i> (Anti-diabetic activity), <i>Asrajit</i> (balances blood disorders, <i>Rasayan</i> (immunomodulatory), <i>Kushthaghna</i> (anti-leprosy activity), <i>Kasaghna</i> (Relives cough), <i>Medhya</i>	<i>Kapha Pitta</i> <i>Shaman</i> (balancing)
Ashwagandha ^[19] (<i>Withania somnifera</i> Dunal)	<i>Rasa- Katu</i> (pungent), <i>Tikta, Kashay</i> <i>Vipaka- Madhur</i> <i>Veerya- Ushna</i> (hot potency) <i>Guna- Laghu, Snigdha</i> (unctuous)	<i>Shothahara, Kshayahara</i> (drugs which improves body weight), <i>Balya</i> (gives strength), <i>Rasayan, Shukrala</i> (aphrodisiac) <i>Nidrajanana</i> (sleep inducing drugs)	<i>Tridosha shamak</i> (Balance all <i>Doshas</i>)

Shankhapushpi ^[20] (<i>Convolvulus pluricaulis</i> Chois)	Rasa- Katu, Tikta, Kashay Vipaka- Madhur Veerya- Sheeta Prabhav- Medhya Snigdha, Picchila (slimy)	Medhya, Vrushya (aphrodisiac/eugenics), Manasarogahruta (anti-psychotic), Rasayan, Smrutiprada, Krumihara (antihelmentic), Vishaghna, (anti- toxic)	Tridosha shamak
Mandukaparni ^[21] (<i>Centella asiatica</i> Linn)	Rasa- Tikta, Kashay Vipaka- Madhur Veerya- Sheeta Prabhav- Medhya Laghu	Shothahara, Jvarahara, Pandughna, Swarya, Smrutiprada, Mehaghna, Asrajit, Rasayan, Kushthaghna, Kasaghna, Medhya	Kapha Pitta Shaman
Kapikacchu ^[22] (<i>Mucuna pruriens</i> DC)	Rasa- Madhur, Tikta Vipaka- Madhur Veerya- Ushna Guru, Snigdha	Vrushya, Bruhan (body weight enhancer), Vatahara (balance vitiated Vata Dosha), Balya, Raktapittashamana (pacifies vitiated Rakta & Pitta), Vaajikaran (Aphrodisiac)	Vata Pitta Shaman
Amalaki ^[23] (<i>Emblca officinalis</i> Gaertn)	Rasa- Amla Rasa Pradhan Lavan Varjit Pancharasa/ (contain 5 taste except Lavan (salty) & in that main Amla rasa (sour) Vipaka- Madhur Veerya- Sheeta Guru, Ruksha (dry)	Medhya, Raktapittahara (pacifies vitiated Rakta & Pitta), Pramehaghna (Anti-diabetic), Rasayan, Chakshushya (gives strength to eyes), Vrushya	Tridosha shamak
Yashtimadhu ^[24] (<i>Glycyrrhiza glabra</i> Linn)	Rasa- Madhur Vipaka- Madhur Veerya- Sheeta Guru, Snigdha	Chakshushya, Balya, Shukrala, Svarya, Raktapittahara, Vishaghna, Glanihara (fatigue reliving), Kshayahara, Kshayahara	Tridosha shamak
Guduchi ^[25] (<i>Tinospora cordifolia</i> Willd)	Rasa- Katu, Tikta, Kashay Vipaka- Madhur Veerya- Ushna Prabhav- Medhya Laghu	Medhya, Rasayan, Vayasthapan (delay aging process), Raktapittahara, Balya, Pramehaghna, Panduhara, Jvarahara, Chakshushya	Tridosha shamak
Vacha ^[26] (<i>Acorus calamus</i> Linn)	Rasa- Katu, Tikta Vipaka- Katu Veerya- Ushna Prabhav- Medhya Laghu, Tikshna (Sharp)	Apasmar (epilepsy), Unmad (insanity), Svarya, Krumighna, Balya,	Vata Kaphahara
Kushmand ^[27] (<i>Benincasa hispida</i> Thunb)	Rasa- Madhur Vipaka- Madhur Veerya- Sheeta Prabhav- Medhya Laghu, Snigdha	Pushtiprada (gives strength), Kshayahara, Vrushya, Balya, Hrudy (cardio tonic), Chetovikarnashana (anti-psychotic)	Tridosha Shamak
Jyotishmati ^[28] (<i>Celastrus paniculatus</i> Willd)	Rasa- Katu, Tikta Vipaka- Katu Veerya- Ushna Tikshna Prabhav- Medhya	Buddhiprada, Smrutiprada, Medhya,	Vata Kaphahara

Jatamansi ^[29] (<i>Nardostachys jatamansi</i> DC)	<i>Rasa- Tikta, Kashay, Madhur</i> <i>Vipaka- Katu</i> <i>Veerya- Sheeta</i> <i>Prabhav- Bhutaghna</i> <i>Laghu, Snigdha</i>	<i>Medhya, Balya, Raktapittahara, Jvarahara, Vishaghna</i>	<i>Tridosha Shamak</i>
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Table 2: Neuropharmacological actions of plants

Sr No	Plant	Neurological actions
1	Brahmi (<i>Bacopa monnieri</i>)	Antioxidant, ^[30] Anticholinesterase, ^[31] Reduction of B amyloid/ Anti-amyloidogenic, ^[32] Neuroprotection, ^[33] Cognitive enhancement, ^[34] Acetylcholine esterase inhibition, ^[35] NMDA antagonism, ^[36] Dopaminergic activity ^[37]
2	Ashwagandha (<i>Withania somnifera</i>)	Neuritic regeneration and synaptic reconstruction activity, ^[38] Anxiolytic activity, ^[39] Antioxidant activity, ^[40] Anticholinesterase activity, ^[41] NMDA antagonist, ^[42] Dopaminergic activity, ^[43] Reduction of B amyloid/ Anti-amyloidogenic, ^[44] Neuroprotection, ^[45] Acetylcholine esterase inhibition, ^[46] Dopaminergic, ^[47] Inhibition of Tau aggregation. ^[48]
3	Shankhapushpi (<i>Convolvulus pluricaulis</i>)	Anxiolytic and memory enhancing Mood elevating effect, ^[49] Antioxidant and Neuroprotection, ^[50] Reduction of B amyloid, ^[51] Inhibition of tau aggregation, ^[52] Acetylcholine esterase inhibition, ^[53] Inhibition of Tau aggregation. ^[54]
4	Mandukaparni (<i>Centella asiatica</i>)	Cognitive enhancement, ^[55] Antioxidant, ^[56] Anticholinesterase, ^[57] Reduction of B amyloid/ Anti-amyloidogenic, ^[58] Neuroprotection, ^[59] Acetylcholine esterase inhibition, ^[60] NMDA antagonism, ^[61] Dopaminergic, ^[62] Inhibition of Tau aggregation, ^[63]
5	Kapikacchu (<i>Mucuna pruriens</i>)	Antioxidant, Neuroprotective and Dopaminergic, ^[64]
6	Amalaki (<i>Embllica officinalis</i>)	Antioxidant ^[65] , Anticholinesterase activity ^[66] , Dopaminergic activity ^[67] , Neuroprotection ^[68] , Acetylcholine esterase inhibition ^[69]
7	Yashtimadhu (<i>Glycyrrhiza glabra</i>)	Antioxidant, ^[70] Anticholinesterase, ^[71] Reduction of B amyloid, ^[72] Neuroprotection, ^[73] NMDA antagonism, ^[74] Dopaminergic. ^[75]
8	Guduchi (<i>Tinospora cordifolia</i>)	Antioxidant, ^[76] Anticholinesterase, ^[77] Neuroprotection, ^[78] Dopaminergic activity, ^[79] Reduction of B amyloid, ^[80]
9	Vacha (<i>Acorus calamus</i>)	Antioxidant, ^[81] Anticholinesterase activity, ^[82] Dopaminergic activity, ^[83] NMDA antagonist, ^[84] Reduction of B amyloid, ^[85] Neuroprotection, ^[86]
10	Kushmand (<i>Benincasa hispida</i>)	Anticonvulsant activity, ^[87] Antioxidant, ^{[88],[89]} Antidepressant, ^[90] Anxiolytic Effects, ^[91] Dopaminergic ^[92]
11	Jyotishmati (<i>Celastrus paniculatus</i>)	Sedative and anticonvulsant properties, ^[93] Antioxidant, ^[94] Cognitive enhancement and neuroprotective effect, ^[95] Anti Alzheimer activity, ^[96] Antianxiety, ^[97] Acetylcholine esterase inhibition, ^[98] NMDA antagonism, ^[99] Dopaminergic activity ^[100]
12	Jatamansi (<i>Nardostachys jatamansi</i>)	Antidepressant activity, ^[101] Anticonvulsant activity, ^[102] Antiparkinson activity, ^[103] Nootropic activity, ^[104] Antioxidant and stress relieving activity, ^[105] Neuroprotective activity, ^[106] Acetylcholine esterase inhibition, ^[107] Dopaminergic. ^[108]

DISCUSSION

Long-term side effect of COVID-19 is Brain Fog which occurs irrespective of the severity of the infection. These brain fog related symptoms appear in approximately 1/3rd of survivors such as confusion, short-term memory decline, multitasking problems, or sleep disorders.

Enlisted plants showed anti-oxidant, acetylcholine esterase inhibition, anti-amyloidogenic, antidepressant activity, antiparkinsonian activity, anxiolytic activity, cognitive enhancement, cognitive enhancement, dopaminergic activity, inhibition of tau aggregation, memory enhancing mood elevating effect, neuritic regeneration, neuroprotection, nmda antagonism, reduction of b amyloid, sedative and anticonvulsant properties, synaptic reconstruction activity in preclinical and clinical studies.

As per Ayurveda plants, which were reviewed, possess properties like *Smrutiprada*, *Medhya*, *Balya*, *Rasayan*, *Nidrajanana*, *Medhya*, *Manasarogahruta*, *Glanihara*, *Apasmar*, *Unmad* and *Chetovikarnashana*.

Rectification of Cognitive Impairment/Defects

Cognitive impairment can be rectified with following measures which leads to Memory enhancement (i.e., Nootropic like effect) –

- a. Antioxidant activity
- b. Anticholinesterase activity
- c. NMDA antagonist
- d. Anti-Neurodegeneration/Neuroprotection
- e. Dopaminergic activity
- f. Removal of amyloid plaques.
- g. Inhibition of Tau aggregation

Antioxidant Activity

Metabolically active brain is more susceptible to Oxidative Stress, it possesses high levels of pro-oxidant iron which is composed of unsaturated lipids which are prone to lipid peroxidation. Entering of exogenous anti-oxidants is prevented by blood-brain barrier this hampers quenching of Reactive Oxygen Species (ROS) in the brain. Oxidative stress is a pathological state in which reactive oxygen/nitrogen species (ROS/RNS) does oxidative modification of lipid, protein, DNA and can cause tissue injury and accelerated cellular death. Antioxidants are compounds that prevent free radicle induced cell damage by inhibiting the oxidation. Antioxidant activity prevents all these reactions.

Anticholinesterase Activity

AChE inhibitors prevent enzyme activity across synapse thereby increase Ach and stimulates postsynaptic cholinergic receptors in the central and/or peripheral nervous systems. AChE inhibitors maintain the ACh level through slowing down its hydrolysis rate and enhancing cholinergic

neurotransmission in forebrain regions and repair damage of functioning brain cells.

NMDA Antagonist: NMDA (N-methyl-D-aspartate) receptor antagonists improve cognitive function and prevent brain damage. NMDA receptor facilitates calcium (which is essential for the learning process and memory) release in to nerve cells by binding of glutamate to excitatory neurotransmitter. In the event of increase in glutamate level causing excess release of calcium and prohibiting binding of glutamate, NMDA antagonists bind to NMDA receptors thereby preventing the release of calcium into the nerve cells thus preventing nerve cell damage.

Neuroprotection: By means of antioxidant activity, NMDA antagonist

Dopaminergic Activity: Dopamine-receptor agonists bind to the neurons which produce utilize dopamine in the absence of neurotransmitters. Stimulation of the receptors in the brain increases Dopaminergic activity. Catecholamine like Dopamine, epinephrine and nor epinephrine are degraded by Catechol-O methyltransferase (COMT; EC 2.1.1.6).

Monoamine Oxidase Type B (MAO-B) enzyme breaks down several chemicals in the brain like dopamine. Motor symptoms can be improved using compounds which nullify the effect of MAO-B leading to more dopamine available to be used by the brain.

Anti-amyloidogenic activity/Removal of amyloid plaques: Neurotoxic interactions to the neuron membranes and membrane receptors creates A β neurotoxicity. Because of exposure of synapse to A β , oxidative-stress-mediated mechanism creates malfunction of membrane ion and glutamate transporters which compromises mitochondrial function. A β -induced oxidative stress results in malfunction and degenerates synapses in Alzheimer disease (AD). Amyloid plaques are formed by disproportion between A β production and A β clearance. These deposited plaques within the brain results in neuronal cell loss and disturbed synaptic function. Therapeutic targets for prevention of accumulation of amyloid beta-peptide and the formation of beta-amyloid fibrils and neutralize preformed beta-amyloid fibrils in the CNS can be helpful in neurological disorders.

Inhibition of Tau aggregation- stability of microtubules thus creating regulation of intracellular exchange is done by Tau. Function of Tau is hampered in progressive supranuclear palsy Pick disease, dementia, stroke and Alzheimer disease leading to the development of intraneuronal neurofibrillary tangles (NFTs).

Cognitive Process as per Ayurveda

Memory is combination of power of acquisition (*Grahana/Dhee*), retention (*Dharan/Dhruti*) and recollection (*Smarana/Smruti*). *Uha* (cognition) is accomplished by series of events of *Artha* (object of senses), *Indriya* (organ), *Manas* (the sensory or processing mind) and *Atma* (soul) in which *Indriya* (organ) receive *Arthas* in association with *Manas*. After this, process of actual analysis of perception is done by *Manas*, which is termed as *Chinta* (cerebration), *Vichara* (consideration), *Uha* (cogitation), and *Sankalpa* (conviction). So initially *Manas* comprises of determination to perception that is journey from perception to determination, i.e., *Adhyavasaya* (mental effort) or *Nischayatmaka Buddhi* (determined knowledge) consequently *Manas* is related with *Karmendriyas* (motor organs). As *Manas* is *Ubhayatmaka Indriya* it synchronizes *Dnyaanendriya* (sense organs) and *Karmendriyas* (motor organs). Once this knowledge is sensed by *Dnyaanendriya*, *Manas* with the hand of *Nischayatmaka Buddhi* result in desired reflex action called as *Karma*. So we can conclude that *Manas* plays pivotal role in *Pradnya* by which *Karmas* are being done. *Vata* regulates actions of *Manas*, in Covid-19 vitiation of *Vata* is there, this hampers function of *Manas*. *Charaka* opines *Buddhi* (*Pradnya*) as “*Nischyatmakamjnanam*”. *Amarkosha* termed *Pradnya* and *Buddhi* as synonyms. *Dhee* (power of acquisition), *Dhruti* (power of retention) and *Smruti* (power of recollection) are the forms of *Buddhi*. Differentiation between *Hita* (wholesome) and *Ahita* (unwholesome) is understood with the help of *Dhee*.

Factors which can have good or bad effects on *Sharir* and *Manas* are called as *Hita* and *Ahita* respectively. Regulation of *Manas* and balance of attitude and orientation is done by *Dhruti*. While recollection of past experiences and knowledge is done by *Smruti*. *Raja*, *Tama*, and *Satva* are the qualities of mind. *Tama* by its *Samvarana Swabhava* (obscuring nature) results in lack of *Smruti*. Proportion, and interaction of these determines the character of a person. Vitiating *Tamas* causes *Budhironirodha* (impaired cognitive functions). *Tama* cannot establish its actions without *Raja* as there is a continual relation between the *Raja* and *Tama*. *Vata* is described as *Rajobahula* (excessive *Raja*). *Vata* is in balanced state intellectual functioning by *Buddhi* remains balanced. In the event of vitiating *Vata* *Rajo Vriddhi* (increased *Raja*) takes place. As *Raja* and *Tama* are in continual relation *Tama* also get imbalanced. This increase in *Raja* and *Tama* is followed by *Avaran* (obstruction) of *Buddhi* and *Manas* leads to cognitive function impairment.

Relation of Dosha- Dhatu in Cognitive Function
Vata- Indirectly concerned with *Medha* by playing role in the whole process of perception up to recall. It

coordinates between all senses and helps in understanding of their objects and perception. Regulation of *Buddhi* and *Manas* is done by *Prana Vayu* while recollection of past knowledge is regulated by *Udana Vayu*.

Pitta

Promotion of *Medha* is mainly done by *Sadhaka Pitta*, *Buddhi* and *Abhimana*. *Pitta* is responsible for *Medha* and *Pradnya* because *Pitta* is *Agni Mahabhoot* dominant. *Agni Mahabhoot* is formed by *Sattva* and *Raja Gunas*. *Sattva* is responsible for cognition while *Rajas* stimulates activities in the body. Due to opposite properties in *Pitta*, it dispels the *Kapha* and *Tama* responsible for obstruction in *Hrudaya*. By relieving this obstruction it facilitates *Manasa* to perceive the things.

Kapha

Proper functioning of *Buddhi* entirely depends on the balanced state of *Kapha*. *Kapha* by its *Snigdha* and *Sthira Guna* helps in retention of knowledge for a long period. Knowledge and intelligence control is controlled by *Tarpaka* and *Avalambaka Kapha*. *Kapha* plays important role in maintaining best qualities of *Dhruti* which controls the unsteadiness of mind.

Dhatu

Among the seven *Dhatu*s the best qualities of *Rasa* (*Twak*), *Rakta*, *Mansa*, *Majja* and *Oja Dhatu* improves the functions of *Medha*. *Buddhi* is nourished by *Rasa Dhatu* whereas promotion of the *Medha* and *Mansvita* is done by *Rakta*. So it facilitates the proper perception. *Mansa Sarata* indicates strong *Dhruti* and knowledge likewise *Majja* of best quality stated to strengthen the learning and knowledge. *Oja* is the essence of all *Dhatu*s. Good quality of *Ojas* has effect on *Buddhi*, as *Ojas* is important for their nourishment. It communicated to the external and internal organs for their own actions. *Karmendriyas* are external organs while *Manas*, *Buddhi* etc are Internal.

So best qualities of *Medha* entirely depends on best qualities of *Prana* and *Udan Vayu*, *Sadhak Pitta*, *Tarpaka* and *Avalambaka Kapha* and *Dhatu* like *Rasa*, *Rakta*, *Mansa*, *Majja* and *Ojas*. A vitiation of any of these factors will reflect upon the faculties of *Medha*.

Nidra

Nidra (sleep) is one of the important pillars (*Trayopastambha*) which sustain life. Proper *Nidra* protects growth and development of body (*Dhatu Pushti*). *Nidra* helps to get proper learning capacity (*Gyan*). *Oja* which is responsible for our immunity also relies on sleep to stay healthy. Quality sleep at night is a natural and nourishing phenomenon, because of this it is termed as *Bhutadhatri* (nourishes all living beings). It is also termed as *Vaishnavi Maya* because it nourishes and gives good health like Lord *Vishnu*, who nourishes and sustains this world.

In *Charaka Samhita* while describing the benefits of *Nidra* it is described that *Sukha, Dukha, Pusti, Karsya, Bala* and *Abala, Vrushata, Klaibata, Jyana* and *Adyana* are dependent upon the *Nidra*. (**Charaka Sutrasthana 21/36**)

Atura qualities

Charaka has mentioned the four qualities of *Atura* (patient) like *Smruti* (good memory), *Nirdeshakaravta* (obedience), *Abhirutva* (fearlessness) and *Roga Dnyapaka* (uninhibited expression). Here *Charaka* has placed *Smruti* first, may be to give it more emphasis than of the other qualities. For *Atura Smruti* is essential to narrate his complaints with exact duration and sequences which helps *Vaidya* to diagnose and treat the problem. *Medha* is also needed to follow the treatment schedule given to him by *Vaidya*. *Atura* has to answer about the history of disease asked by *Vaidya*. It is possible only if *Atura* is possessed with good retention power. (**Charaka Sutrasthana 9/9**)

Role of Medha in Health and Disease

Charaka opines that in a person by virtue of his bad action *Dhee* (intellect), *Dhruti* (patience) and *Smruti* (memory) get impaired because of this person subjects himself to lack of reverence towards intellect. It is called *Pragyapradha* which further aggravates all the *Doshas*. (**Charaka Sharir 1/102**)

Medhya Karma

1. *Sheeta Veerya* and *Madhur Rasa, Vipaka* promotes *Kapha* and enhances "*Dhruti*" (i.e., retention of cognition) e.g., *Brahmi, Mandukaparni, Shankhapushpi, Kapikacchu, Amalaki, Yashtimadhu, Kushmand.*
2. *Ushna Veerya* and *Tikta Rasa-* it stimulate *Pitta* and enhances *Dhee* and *Smruti* (i.e., grasping power and Memory) e.g. *Ashwagandha, Guduchi, Vacha, Jyotishmati.*

Action of *Medhya* drugs is done by stimulation and enhancement of *Agni*, by improving *Rasa Dhatu* and removal of obstructions in micro channels thus improving circulation of *Dhatu*.

Bramhi- *Bramhi* by its *Tikta* and *Laghu Guna* stimulate the *Agni* and make *Ama Pachana*, removes *Mala* thus removes *Jadya* over *Medha*. Acts at the level of *Rasa Dhatu* by improving the nutrition of the faculties of *Medha*. *Bramhi* by its *Sheeta, Snigdha, Manda, Sthira, Mrudu, Drava* and *Madhur Vipaka* increase the *Kapha* in general and *Tarpaka* and *Avalambaka Kapha* in particular which nourishes the *Dhruti*. *Kashaya Rasa* acts as *Srotas Shodhana* due to cleansing property (*Vishadaguna*) and improve the functions of *Medha*.

Ashwagandha- By its *Katu, Tikta* and *Laghu Guna* stimulate the *Agni* and make *Ama Pachana*, removes *Mala* thus removes *Jadya* over *Medha*. Acts at the level of *Rasa Dhatu* by improving the nutrition of the faculties of *Medha*. *Laghu, Kashaya Rasa* acts as *Srotas*

Shodhan due to cleansing property (*Vishadaguna*) and improve the functions of *Medha*. *Madhur Vipaka* nourish *Dhruti, Smruti & Medha*. By *Ushna Veerya* stimulates the *Sadhakagni* and aids intellectual functions especially regarding *Dhi*.

Shankhapushpi- By its *Tikta* and *Laghu Guna* stimulate the *Agni* and make *Ama Pachana*, removes *Mala* thus removes *Jadya* over *Medha*. Act at the level of *Rasa Dhatu* by improving the nutrition of the faculties of *Medha*. *Shankhapushpi* by its *Sheeta, Snigdha, Manda, Sthira, Mrudu, Drava* and *Madhur Vipaka* increase the *Kapha* in general and *Tarpaka* and *Avalambaka Kapha* in particular which nourishes the *Dhruti*. *Kashaya Rasa* acts as *Srotas Shodhan* due to cleansing property (*Vishadaguna*) and improve the functions of *Medha*.

Kapikacchu- By its *Tikta* stimulates the *Agni* and makes *Ama Pachana*, removes *Mala* thus removes *Jadya* over *Medha*. Acts at the level of *Rasa Dhatu* by improving the nutrition of the faculties of *Medha*. *Madhur Vipaka* nourish *Dhruti, Smruti & Medha*. By *Ushna Veerya* stimulates the *Sadhakagni* and aids intellectual functions especially regarding *Dhi*.

Amalaki- By its *Rasayan Karma* acts at the level of all *Dhatu*s Specially *Majja* and *Oja* by improving their quality and quantity. By its *Amla* and *Katu Tikta Rasa* acts the level of *Agni*, by stimulating and improving the functions of *Sadhakagni*. By its *Tikta Ruksha Guna* at the level of *Srotas* it improves the circulation of *Ahara rasa* by opening and clearing the *Srotas* and ultimately improves the functions of *Medha*. By its *Guru, Sheeta, Mrudu* and *Madhur Rasa* and *Vipaka* acts on the *Tarpaka* and *Avalambaka Kapha* in particular which nourishes the *Dhi, Dhruti, Smruti* and *Medha*. *Amla & Lavana Rasa* acts on the *Pitta* and stimulate *Sadhakagni* which generates *Medha* especially *Dhi*. By its *Katu, Tikta Rasa* stimulates the *Agni* and makes *Aampachan*, removes *Mala* thus removes *Jadya* over *Medha*. Especially *Tikta Rasa* is described as *Medhya*. *Kashaya Rasa* acts as *Srotas Shodhan* due to cleansing property (*Vishadaguna*) and improves the functions of *Medha*.

Yashtimadhu- By its *Guru, Sheeta, Mrudu* and *Madhur Rasa* and *Vipaka* acts on the *Tarpaka* and *Avalambaka Kapha* in particular which nourishes the *Dhi, Dhruti, Smruti* and *Medha*. *Madhur Rasa* is helpful in *Indriya Prasadana* which ultimately helps in *Vishaya Grahana*. The *Medha* and all conscious manifestations are credited to the *Satva-Guna*. *Aap Mahabhoot* is *Satva+Tama Bahula*. Hence *Apya* drugs like *Yashtimadhu* having the *Satva Guna* predominance are mainly responsible for the promotion and nourishment of *Medha*.

Guduchi-By its *Rasayan Karma* acts at the level of all *Dhatu*s Specially *Majja* and *Oja* by improving their quality and quantity. By its *Katu, Tikta* and *Laghu Guna*

stimulate the *Agni* and make *Ama Pachana*, removes *Mala* thus removes *Jadya* over *Medha*. Acts at the level of *Rasa Dhatu* by improving the nutrition of the faculties of *Medha*. *Madhur Vipaka* nourish *Dhruti*, *Smruti* & *Medha*. By *Ushna Veerya* stimulates the *Sadhakagni* and aids intellectual functions especially regarding *Dhi*.

Vacha- By its *Tikta* and *Laghu Guna* stimulate the *Agni* and make *Ama Pachana*, removes *Mala* thus removes *Jadya* over *Medha*. By its *Ushna*, *Teekshna*, *Laghu Guna* and *Katu Vipaka* increase the *Pitta* in general and stimulate *Sadhakagni* which in turn generates *Medha*. *Vacha* by *Sukshma*, *Vishadaguna* improve the circulation of *Ahara Rasa* by opening and clearing the micro channels and thus ultimately improve the functions of *Medha* by removing *Aavaran* of *Kapha* and *Tama Guna* on *Manovaha Srotas*. By this *Vishaya Grahana* (grasping) and its encoding by *Manas* occurs in a better way, which results in the production of *Medha*. *Vacha* is *Teja (Satva + Raja) Bahula*. Hence the *Satva Guna* predominance helps in promotion and nourishment of *Medha*.

Kushmand- By its *Guru*, *Sheeta*, *Mrudu* and *Madhur Rasa* and *Vipaka* acts on the *Tarpaka* and *Avalambaka Kapha* in particular which nourishes the *Dhi*, *Dhruti*, *Smruti* and *Medha*. The *Medha* and all conscious manifestations are credited to the *Satva-Guna*. *Aap Mahabhoot* is *Satva+Tama Bahula*. Hence *Apya* drugs like *Kushmand* having the *Satva Guna* predominance are mainly responsible for the promotion and nourishment of *Medha*.

Jyotishmati- By its *Tikta* and *Laghu Guna* stimulate the *Agni* and make *Ama Pachana*, removes *Mala* thus removes *Jadya* over *Medha*. By its *Ushna*, *Teekshna*, *Laghu Guna* and *Katu Vipaka* increase the *Pitta* in general and stimulate *Sadhakagni* which in turn generates *Medha*. *Jyotishmati* by *Sukshma*, *Vishadaguna* improve the circulation of *Ahara Rasa* by opening and clearing the micro channels and thus ultimately improve the functions of *Medha* by removing *Aavaran* of *Kapha* and *Tama Guna* on *Manovaha Srotas*. *Jyotishmati* is *Teja (Satva + Raja) Bahula*. Hence the *Satva Guna* predominance helps in promotion and nourishment of *Medha*.

Jatamansi- By its *Tikta* and *Laghu Guna* stimulate the *Agni* and make *Ama Pachana*, removes *Mala* thus removes *Jadya* over *Medha*. Acts at the level of *Rasa Dhatu* by improving the nutrition of the faculties of *Medha*. *Jatamansi* by its *Sheeta*, *Snigdha*, *Manda*, *Sthira*, *Mrudu*, and *Drava* acts on the *Kapha* in general and *Tarpaka* and *Avalambaka Kapha* in particular which nourishes the *Dhruti*. *Kashaya Rasa* acts as *Srotas Shodhana* due to cleansing property (*Vishadaguna*) and improves the functions of *Medha*.

Properties of some of the reviewed plants in addition to *Medhya Karma* –

Reviewed plants also possess *Balya*, *Kshayahar*, *Rasayana*, *Nidrajanan*, *Glanihar* and *Hrudya* properties. *Balya* means which gives strength, these drugs gives strength to body by improving *Mansa* and *Oja Dhatu*. *Oja* is important for strength and longevity of life and immunity. *Kshayahar* means which revitalizes body constituents. By this property body gets strength and achieves immunity. *Rasayana* (Rejuvenation of body and psyche) drugs helps in maintaining of homeostasis and prevents degeneration of body tissues. It increases quality and quantity of all *Dhatu*s ultimately leads to increase in *Oja*. *Nidrajanana* drugs help in sleep regulation. *Glanihara* drugs helps in coping with weakness and fatigue. *Hrudya* drugs are cardio tonic by which they keep heart in healthy condition and maintain cardiac function.

Reviewed plants like *Ashwagandha* in addition to *Medhya Karma* possesses properties like *Balya*, *Kshayahara*, *Rasayan* and *Nidrajanana* properties which can be used effectively in long Covid related symptoms. *Yashtimadhu* also possesses properties like *Balya*, *Kshayahara*, and *Glanihara* properties which can relieves weakness and weight loss related issues in Long Covid symptoms. *Kushmand* possess *Balya*, *Kshayahara* and *Hrudya* properties, can be helpful in cardiac complications and weakness arising due to Covid infection. *Guduchi* and *Jatamansi* possess *Balya* property while *Jatamansi* in addition to this possess *Nidrajanana* property which can be helpful in these Covid related symptoms.

CONCLUSION

Virus affecting CNS does impairment of cognitive functions. In the case of “long term Covid infection” this condition gets worst as time passes. This cognitive impairment also can cause decline in immunity towards infection ultimately helps in viral spread.

Significance related with diagnosis, prognosis and long term care is increasing in the case of Cognitive changes associated with COVID-19. So future rehabilitation for mental health issues related to COVID-19 will increase. Cognition is complex process of attention, learning, memory and executive processes. Many therapeutic researches are being studied on optimal disease-relevant drug targets for example acetylcholinesterase inhibitors enhance neurotransmission, nicotinic agonists and 5-HT₆ receptor antagonists stimulate or inhibit key brain receptors and PDE inhibitors activate intracellular signaling series.

Medhya drugs are useful in the prevention and management of cognitive impairments.

This review is focused on the capacity of the traditional Indian medicine system for treating memory related disorders by plant sources. The present study highlights the properties of the selected

plants and their effectiveness and suggests that these medicinal plants can be used for efficient therapeutics with least side effects, good tolerance, or without withdrawal symptoms as compared to the allopathic drugs for the Cognition associated disorders.

In Ayurveda, drugs not only relieve neurological symptoms but also enhance mental capability by acting on immunity also thus keeps the mind and the body free from further damages.

In this discussion evidence based Research data available supports procognitive, Nootropic activity. Reviewed herbs does modulation of biological axis and neurotransmitters with the help of biologically active ingredients present in them. This in turn revalidates the properties of selected herbs mentioned in Ayurveda literature.

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