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Role of active components of Medicinal plants in Neurodegenerative disorders and Synaptic Plasticity

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Abstract: Neurodegenerative disorders are a very common problem in humans. These disorders are directly related with synaptic plasticity. Synaptic plasticity responsible for learning and memory formation. It can be modulated by active components of medicinal plants. Medicinal plants play fundamental role in traditional knowledge. There are more than thousands of medicinal plants to be examined for neuroprotective potential. These approaches can promise for the treatment of various neurological disorders like Alzheimer, depression, stroke etc.
Key point: Alzheimer, depression, stroke, synaptic plasticity.

Introduction

A neurodegenerative disease is defined as deterioration, often irreversible, of the intellectual and cognitive faculties and it is generally associated with ageing and/or Alzheimer, Parkinson, stroke etc [1]. Neurodegenerative disorders are a major cause of mortality and disability and as a result of increasing life spans represent one of the key medical research challenges. Among hundreds of different neurodegenerative disorders, so far lion's share of attention has been given Alzheimer's disease (AD), Parkinson's disease (PD), Huntington disease (HD) and Amyotrophic lateral sclerosis (ALS). The number of neurodegenerative diseases is currently estimated to a few hundred and among these many appear to overlap with one another clinically and pathologically rendering their practical classification quite challenging. Different neurodegenerative diseases are recognized by neuronal phenotypes that are primarily lost and neurological defects that accompany this loss. Neurodegenerative disorders of the Central Nervous System may be grouped into diseases of cortex, the basal ganglia, the brain stem, and the cerebellum or the spinal cord [2].

Neurodegenerative disease like Alzheimer is the sixth leading cause of death in the world. Alzheimer association reported that an estimated 5.2 million American of all ages have Alzheimer disease in 2013. In 2013 Alzheimer's will cost the nation $ 203 billion and this number is expected to rise to $ 1.2 trillion by 2050 [3]. In India also, this problem is growing very fast, Alzheimer is directly associated with synaptic plasticity.

Most neuroscientist believes that learning and memory formation occurs by changing in the strength of synapse. Donald Hebb in 1949 developed a hypothesis about the mechanism of learning and memory at the neuronal level [4]. There are two forms of synaptic plasticity.

1. Long term potentiation (LTP)
2. Long term depression (LTD)

Long term potentiation: LTP is a long-lasting enhancement and input specific in signal transmission between two neurons that results from stimulating them synchronously. LTP induced by NMDARs (N-methyle-D-aspartic acid receptors) and Ca^{2+} ion. AMPARs (α-amino- 3 hydroxy -5- methyl-4-isoxazolepropionic acid receptor) also play an important role in the induction of LTP.

Long term depression: LTD can be defined as a long lasting decrease in the synaptic response of neurons to stimulation of their afferents following a long patterned stimulus. There are various receptors which can trigger the induction of LTD like NMDARs, mGluRs etc.

The role of LTP in disease is less clear than its role in basic mechanisms of synaptic plasticity. However, changes in LTP contribute to a number of neurological diseases, like depression, Parkinson's, epilepsy and neurological pain [5]. Whenever role of LTD in Alzheimer disease is ongoing. Sheng *et al.* in 2012 reported comprehensive discussion of synaptic changes associated with Alzheimer disease [6].

There are various methods, to modulate synaptic plasticity and treat neurological disorders. We know that many herbal plants have curative power and shows therapeutic benefits with low side effects. Many active components like alkaloids, tannins, saponins, phenols, mucilage, flavinoids, coumarins, anthraquinones, anthocyanins etc (shown in table 1) present in herbal plants. These active components can modulate the synaptic plasticity.

Some medicinal plants like *Guduchi, Yashtimadhuk, Padma, Vacha, Shankhpushpi, Gugguli, Musta Arjun, Amalaki, Ashwagandha* and others are excellent herbs for solving down the brain cell degeneration caused by Alzheimer and enhance the brain functions [7].

There are large numbers of plants that need to be examined for their potential neuroprotective properties. This will greatly help in identifying more active compounds with potential application for human. These approaches hold promise for the treatment of various disorders.

Table 1: Some important medicinal plants and their active components:

S.N.	Herbal plants	Useful parts	Active constituents
1.	*Allium sativum*	Bulb	Sallylcysteine
2.	*Bocopa monniera*	Whole plant	Bacosides A & B
3.	*Nicotiana tobaccum*	Leaves	Nicotine
4.	*Withania somnifera*	Roots	Withanolides
5.	*Ricinus communis*	Beans	Ricinine
6.	*Salvia officinalis*	Leaves	Monoterpenoid
7.	*Ginkgo biloba*	Leaves/bark	Ginkgolides
9.	*Huperzia serrata*	Moss	Huperzine
10.	*Uncaria tomentosa*	Bulbs	Alkaloids
11.	*Physostigma vennosam*	Beans	Physostigmine
12.	*Acorus calmus*	Rhizomes	α-Asarone & Methyl isoeugenol

(Adapted from Jagdeep S. Dua *et al* 2009) [8]

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