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Neuroprotective effect of fucoidan from *Turbinaria decurrens* in MPTP intoxicated Parkinsonic mice

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Highlights

Fucoidan is a sulfated polysaccharide, with a wide pharmacological activity without any side effects. It is the main ingredient in the food supplements.

Brown algae are the only source for the isolation of the fucoidan than any other terrestrial or marine source.

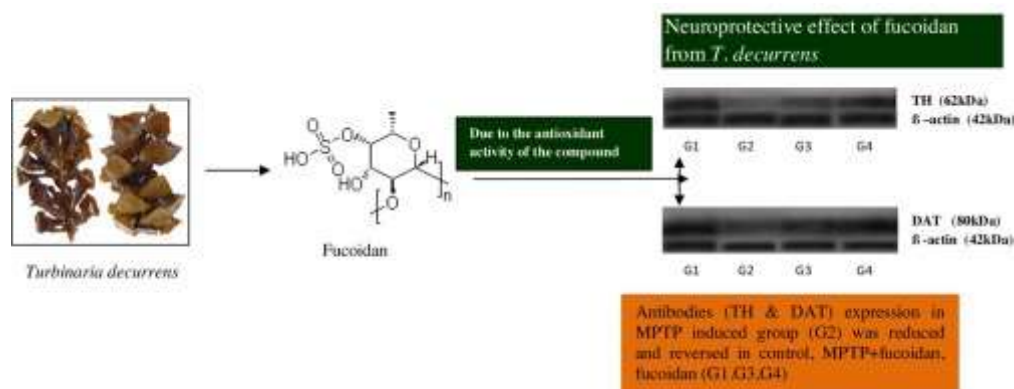
Fucoidan inhibit A-beta accumulation within microglia through multiple scavenger receptors which release the proinflammatory proteins, such as TNF-alpha, or nitric oxide.

Higher protein expression levels of TH and DAT was observed in fucoidan *T. decurrens* administered group.

Abstract

Fucoidan is one of the dominant sulfated polysaccharide which was extracted from the brown seaweed *Turbinaria decurrens*. In the behavioral study mice treated with fucoidan showed better response than the MPTP treated mice. Antioxidants and dopamine level has been increased in the fucoidan treated mice when compared to MPTP induced mice. In Immunohistochemistry, the increase of TH positive cells in the fucoidan treated group is correlated with the TH protein levels in substantia nigra and corpus striatum. The increase is greater than the content of dopamine and DOPAC, which may be explained that the dopaminergic terminals are more sensitive to MPTP toxicity and therefore are more severely damaged than the dopaminergic cell bodies. In immunoblotting TH and DAT was used, both the antibodies expression in MPTP was reduced and reversed in other groups. From the results it was conformed that the fucoidan has a neuroprotective effect without any side effects.

Graphical abstract



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Introduction

Parkinson's disease (PD) is the second most common neurodegenerative disorder, affecting 1% of the population having 65 years of age and increasing upto 3% of the population over 80 years of age [1]. The neuronal loss is slow and progressive and the motor symptoms of the disease appears only after a given threshold of dopamine depletion (70–80%) in corpus striatum and/or dopaminergic neuronal loss (50–60%) in substantia nigra has been reached [2]. Parkinson's disease affects body movement and it is characterized by symptoms such as muscle rigidity, resting tremors, loss of facial expression, hypophonia, diminished blinking, dystonia, cognitive and mood disturbances, dementia, memory loss etc. The motor disabilities characterizing parkinsons disease are primarily due to loss of dopaminergic neurons in the substantia nigra of dopamine in corpus striatum. It has been reported that the risk of disease in men is twice than of women [3]. There has been no uniform, large scale and nationwide epidemiological data or survey on the incidence and prevalence of parkinsons disease in India. It is predicted that in 2016, of a total population (1263 million) 113 million would be over 60 years and 1% (1,130,000) of the population over 60 years may have parkinsons disease [4]. Oxidative stress occurs due to the formation of free radicals and leads to an imbalance between oxidants and antioxidants status, that contributes to the cascade, leading to dopamine cell degeneration in PD.

In the search of new antioxidants, marine algae are now being considered to be a rich source of nutrients and antioxidants [5], [6]. Algal polysaccharides were reported to be useful candidates in the search of effective non-toxic substances. They play an important role as free radical scavengers in vitro and antioxidants for the prevention of oxidative damage in living organisms [7], [8]. Each species of brown seaweed has a characteristic

fucoidan. Some species contain simple sulfated fucans, while others have complex sulfated heterogeneous polysaccharides that contain several monosaccharides [9]. Fucoidan from algae possess important pharmacological activities such as antioxidant [10], anticoagulant and antithrombotic [11], antiproliferative, anti-inflammatory, [12], gastric protection [13], hepatoprotective [8], neuroprotective [14], cardioprotective [15] and so on. Since, the antioxidants play a vital role in the protection of various diseases as described above. Fucoidan has been shown to inhibit A-beta accumulation within microglia through its effects on multiple scavenger receptors which mediate the release of proinflammatory proteins, such as TNF-alpha, or nitric oxide [16]. So, present study was planned to study about the neuroprotective effect of fucoidan against dopaminergic neurodegeneration.

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Section snippets

Collection and extraction of fucoidan

The brown seaweed *Turbinaria decurrens* belonging to the family phaeophyceae was collected in yervadi, India. The specimens were identified and authenticated by phycologist Dr. P. Anantharaman, Faculty of Marine Sciences, Annamalai University, Parangipettai, India. The collected *T. decurrens* was initially washed with seawater to remove the macroscopic epiphytes and other extraneous matter and then rinsed in distilled water. The specimen was shade dried and coarsely powdered. 100g of dried

Effect on behavioral patterns

In open field test, when compared to control mice (group I) significant reduction ($P < 0.05$) was noted in peripheral and central movements along with rearing and grooming of MPTP injected mice (group II). Pretreatment of fucoidan from *T. decurrens* to MPTP administered mice (group III), made them to exhibit increased peripheral and central movements along with rearing and grooming and significantly ($P < 0.05$) (Fig. 1a d).

In narrow beam walking test, MPTP treated mice (group II) were observed to have

Discussion

The MPTP model in mice is used to study neuroprotection because it replicates the key patho-biochemical features of Parkinson's disease such as oxidative stress, mitochondrial dysfunction, excitotoxicity, inflammatory processes and apoptosis [32]. MPTP when administered in mice was found to decrease striatal dopamine level and its metabolite 3,4-dihydroxyphenylacetic acid (DOPAC) contents and locomotor activity [33]. In the present study, the levels of dopamine and its metabolites were

Conclusion

Oxidative stress has been linked to a wide range of diseases which leads to death, fucoidan from *T. decurrens* has the antioxidant potential will inhibit the harm generated by excessive free radicals. In the present study fucoidan showed the neuroprotective effect against MPTP intoxicated rats without any side effects and the results of the present investigation will take a lead toward the isolation of compound from natural resources for the deadly diseases.

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...Indeed, the SH-SY5Y cell-line is used as an in vitro neurodegenerative model induced by 6-OHDA to study the death of dopaminergic neurones [71,73]. Some studies have described that SPs possess neuroprotective action on in vitro and in vivo experiments [37,74–80]. Therefore, we analysed whether 6-OHDA-induced neurotoxicity on SH-SY5Y cells could be attenuated by Hm-SP...

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