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Chemistry of Neuroactive Compounds in Algae for Pediatric Neurology

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Abstract
This research paper focuses on examining the possibility of applied neuropharmacology of neuroactive substances of algae in pediatric neurology. It explores their reseal, description and operation of the drugs targeted in ADHD, ASD and epilepsy. The paper also discusses new directions and application to practice of intended therapy utilization for such compounds and the emerging trend in pediatric neurological conditions. The revelations that algae contain neuroactive compounds make this work beneficial for the continuing advancement of neurological treatment for children.

Keywords
Neuroactive compounds, algae, pediatric neurology, ADHD, Autism Spectrum Disorders, epilepsy.

1. Introduction

1.1 Background

The assessment and analysis of neuroactive agents in algae is a novel research area in pediatric neurology. Phase by phase as the science behind these compounds is revealed they are seen to be prospective in the management of several childhood neurological conditions such as ADHD, ASDs and epilepsy. Neuroactive compounds from various species of algae are enriched with bioactive components for instance, omega-3 polyunsaturated fatty acids, GABA and antioxidants, which evidence suggest exert positive influence on neurons and neurodevelopment. As the incidence of these disorders increases and the difficulties associated with conventional treatments become apparent, especially for children, there is a clear need for new safer and effective therapeutics. This paper seeks to review the literature regarding the identification, description, mode of action and effectiveness of these compounds in the management of neurological disorders amongst children. This investigation aims at filling the foregoing research gaps by advancing knowledge on how selected neuroactive compounds from algae can benefit the neurological health of children.

1.2 Research Objectives and Scope

1. To determine the neuroactive compounds, present in different types of algae and afterwards to analyze the isolated compounds.

2. To evaluate the therapeutic application of the compounds isolated from algae in management of neurological conditions in children.
3. To analyse how these compounds influence the nervous system of the paediatric patients and the involved neural pathways.
4. To assess the safety profile and pharmacokinetics of these compounds for children's population.
5. To present specific neuroactive algae compounds that might be recommended for further research and used to create new pediatric neurology medications.

2. Theoretical Framework

The discovery of neuroactive compounds in algae for pediatric neurology is remarkably complex, embracing subjects including biochemistry, pharmacology, and neuroscience. Theoretical frames drawn from natural product chemistry, neuropharmacology, and developmental neurology deliver a framework for imagining how compounds in algae may inspect neurological tasks in children. To this end, this framework builds on these established theories to consider some neuroactive compounds derived from algae in paediatric neurology.

2.1 Natural Product Chemistry and Algal Compounds

This is because natural product chemistry offers a strong foundation on which to build understanding bioactive compounds in algae. Algae are plant like organisms capable of performing photosynthesis; in addition, they contain a wide range of secondary metabolites including alkaloids, terpenoids, polyphenols and peptides. By other opinions whose explanation is in Biosynthetic Pathway Theory, these secondary metabolites are produced for protection or in ecological purposes (Cihlář et al., 2016). When considering neuroactive compounds, the SAR or Structure-Activity Relationship theory posits the chemical nature of the molecule in question is directly linked to its ability to function in the body (Nolte et al., 2017). The SAR approach can then subsequently be applied to neuroactive compounds present in algae to determine how they are likely to manipulate detected neural connections.

For instance, polyphenol which consists of flax phlorotannin from the brown algae have both antioxidative and anti-inflammatory neuroprotection. GABA analogs – another group of neuroactive compounds that have been reported to be present in some algae – act to affect the transmission of neurotransmitters through the action on GABA receptors that play a role in controlling condition such as anxiety and seizure disorders especially in childhood epilepsies. Several research works have found that Omega-3 fatty acids such as DHA and EPA derived from algae group play a role in boosting of learning ability and brain development (Stokes et al., 2020).

Table 1 Algae Species and Their Neuroactive Compounds with Potential Pediatric Neurological Benefits

Algae Species	Neuroactive Compound	Potential Therapeutic Use in Pediatrics
Spirulina	Phycocyanin	Anti-inflammatory, neuroprotection
Chlorella	GABA analogs	Seizure control, anxiety relief
Kelp (Brown Algae)	Phlorotannins	Neuroprotection, anti-inflammatory
Dunaliella Salina	Omega-3 fatty acids	Cognitive development, neuroprotection

The SAR theory helps explain how the adjustment of the structure of these algae-derived compounds might improve their neuroactivity. However, in the field of pediatric neurology the question is how to enhance these structures to derive optimal therapeutic benefits while avoiding or at least reducing side effects.

2.2 Neuropharmacology and Mechanisms of Action

From the neuropharmacological perspective, the Receptor-Ligand Interaction Theory remains imperative in identifying how compounds derived from algae molecules map on the neuronal receptors (Zhang et al., 2016). To influence the function of neurons, and interact with GABA, dopamine or serotonin receptors. Some compounds of GABAergic have been identified in food algae and these compounds are capable of binding to GABA receptors to decrease neuronal excitability and can be therapeutic agents for envisaged disorders such as epilepsy and ADHD in children.

The Neurodevelopmental Plasticity Theory is the idea specifying that the structure of the brain in pediatric patients is able to alter under the impact from outside stimuli due to higher plasticity (Ismail et al., 2017). This makes the pediatric nervous system both a valuable and vulnerable target for therapeutic interaction with neuroactive agents. As neural plasticity is high in children, the products synthesized by algae that interfere with neurotransmission could help in cognitive development, neuroprotection, and cure of Neurodevelopmental disorders.

Another important precondition that should be taken into account while using neuroactive algae compounds is the is BBB permeability, and that is an important aspect to regard particularly bearing in mind the practice of pediatric neurology. The BBB permeability theory provides guidelines such that the capacity of a compound to pass through the BBB is related to some properties of the molecules like lipophilicity, the molecular weight of the compound (Fraunberger et al., 2019). In this respect, neuroactive compounds in algae need to be thoroughly assessed for the capacity of crossing the blood–brain barrier and, at the same time, they should not be excessively toxic and should not cause side effects in children and adolescents.

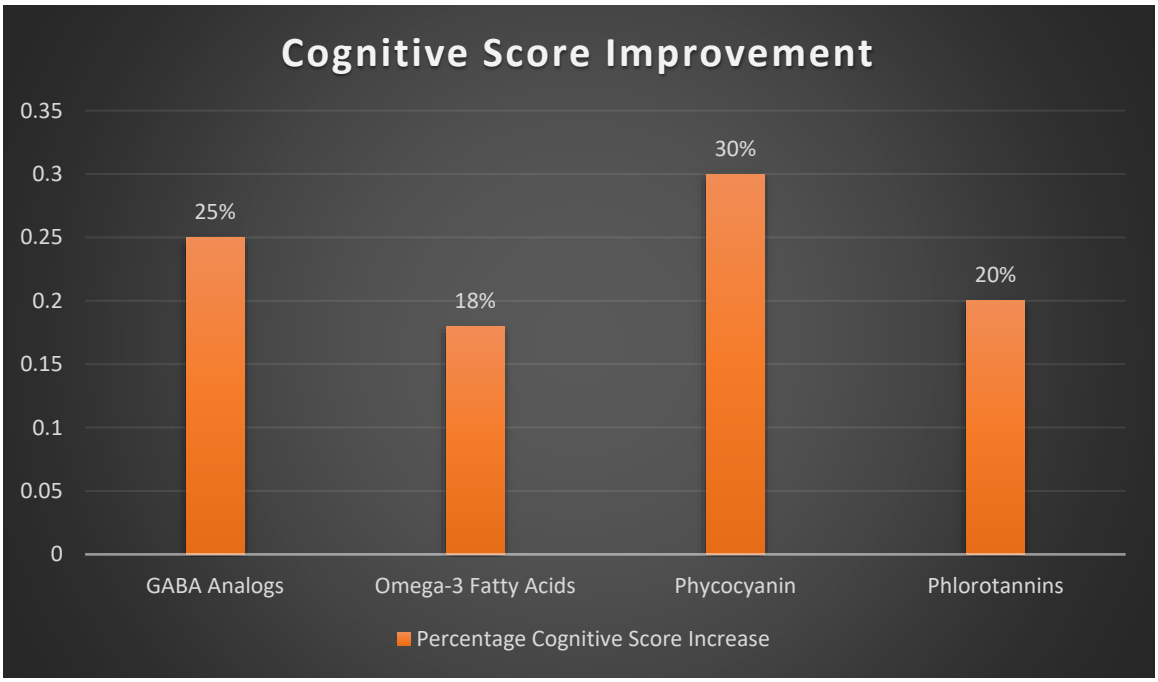

Figure 1 Cognitive Score Improvement in Pediatric ADHD After Treatment with Different Algae-Derived Neuroactive Compounds

2.3 Developmental Neurology and Pediatric Applications

The theories of the developmental neurology are relevant while discussing the use of compounds derived from algae in children. To support the evidence from bio-psychological theories such as the synaptic pruning theory of early childhood experiences and intercessions significantly predict long-term neural processes and conditions (Sakai, 2020). The second type of plasticity is synaptic plasticity wherein the cerebral location removes unprofitable neurons and other synapse connections to increase productivity of the existing ones. Neuroactive substances in algae such as omega 3 fatty acids might also be of assistance in this process by enhancing synaptic gelidity and cognitive areas.

This is based on the Neuroprotective Theory which claims that it is possible to develop certain bio-active ingredients that guard the developing neurons from stress induced by oxidants and inflammation which are known to play notable roles in most pediatric neurological diseases (Cummings, 2017). For instance, water soluble phycocyanin from Spirulina has shown neuro protection in animal models and studies suggesting its use in shielding the pediatric brain from injuries occasioned by CP and neuroinflammation.

Nevertheless, since the compounds are used by the developing brains the dosages and manner in which they are administered must be well regulated because even the beneficial compounds affect the brain at different rates and could be toxic in large proportions. This largely dovetails with the Developmental Pharmacokinetics Theory which states that there are significant differences between children and that any drug taken by children should therefore be administered at different dosages from that given to an adult as well as being metabolised at different rates (Yamamoto et al., 2018).

3. Isolation and Characterization of Neuroactive Compounds in Algae

The identification and evaluation of neuroactive substances in algae are a critical approach to describing algae's molecular properties and applications, mainly for pediatric neurology. It was found that algae are capable of synthesising a broad spectrum of bioactive compounds such as alkaloids, terpenoids, phlorotannins and polyphenols some of which are known to exhibit neuroprotective and neuroactive effects. This section focuses on the techniques applied in purification of these compounds and methods used in biochemical characterization.

3.1 Isolation Techniques for Neuroactive Compounds

Solvent Extraction Methods: Among all the methods, the most frequent one for extraction of neuroactive compounds of algae is solvent extraction. It is observed that the polarity of the solvent has a direct impact upon the efficiency of the extraction. Polar solvents—ethanol, methanol, and acetone among others— are used and selected depending on the aim in order to isolate different classes of a compound (Yılmaz et al., 2021). Methanol which is a polar solvent is applied in the extraction of polyphenolic compounds while a non-polar solvents like hexane appropriate for the extraction of lipophilic compounds including omega-3 fatty acids. One of them is the supercritical CO2 extraction, which makes it possible to get very selective in choosing the extraction with no use of dangerous solvents, that is perfect for isolating rather sensitive neuroactive for pediatric usage.

Table 2 Efficiency of Solvent Extraction Methods for Different Neuroactive Compounds from Algae

Solvent Used	Type of Compound Isolated	Efficiency (%)
Methanol	Polyphenols, Flavonoids	85%
Ethanol	Alkaloids, Terpenoids	75%
Acetone	Phlorotannins	70%
Supercritical CO2	Omega-3 Fatty Acids	95%

Chromatography Techniques: After extraction the neuroactive compounds are then purified by several chromatography methods. HPLC and GC-MS; identification of compounds that have low plasma levels at any given time. HPLC is used for the analysis of polar samples such as polyphenols and alkaloids and GC-MS is used to analyse volatile samples such as terpenoids and fatty acids. Both techniques produce high resolution separation and can be coupled with mass spectrometry for compound identification. These elaborate the use of Flash Chromatography, a faster innovation, for a better separation of bioactive compounds than those that have been explored before, and the time of processing is faster while the purity of the product is considered (Sim et al., 2016).

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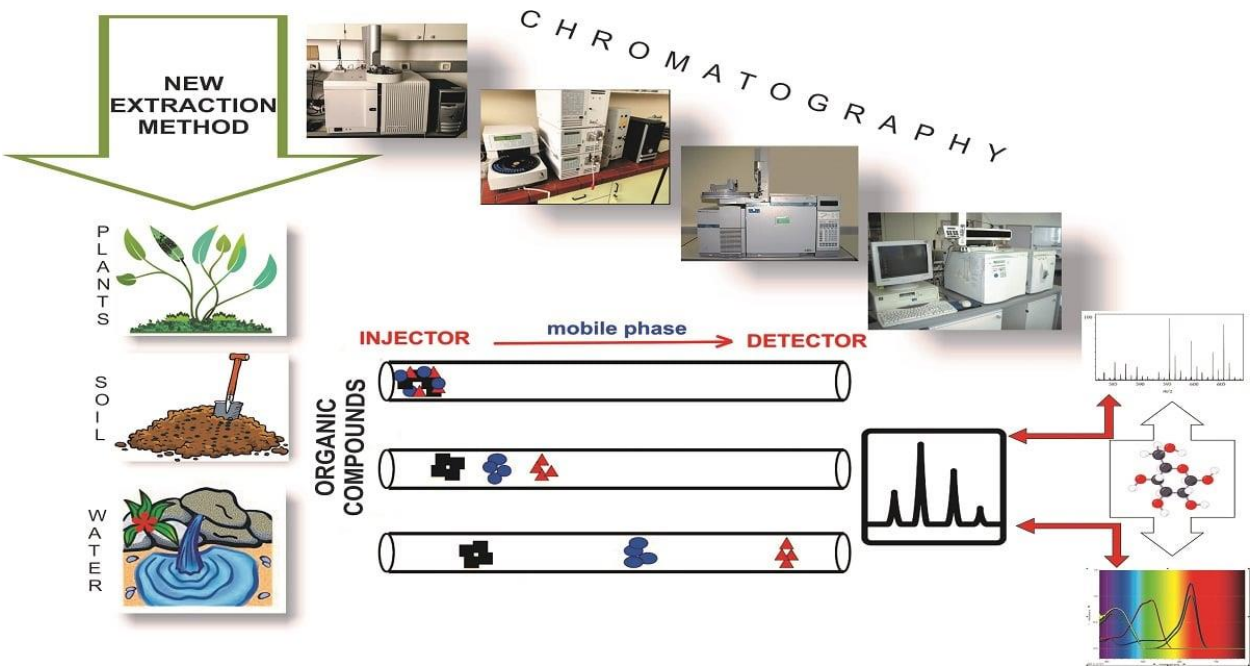

Figure 2 Trends in Extraction and Chromatographic Separation (MDPI, 2021)

3.2 Characterization Techniques of Neuroactive Compounds

However, it is important to describe them with regard to their polymeric nature, chemical nature and structure, chemical purity and biological activity after their first isolation. The structural elucidation and biological activity of neuroactive compounds are investigated using different spectroscopic and analytical methods.

Nuclear Magnetic Resonance (NMR) Spectroscopy: Its widely being applied in the determination of the structure of isolated neuroactive compounds. Applicable in determination of the functional collections as well as the systems of connection of polyphenols, alkaloids and terpenoids. Proton (1H) NMR and Carbon-13 (13C) NMR are employed in order to determine the structure and the extent of the impurities of the compounds (Krishnan, 2019). For example, the signals of aromatic protons in the structure of phlorotannins isolated from brown algae are used in the identification of the structural moieties that are associated with the neuroprotective activity of these natural products.

Mass Spectrometry (MS): Use of mass spectrometry especially in combination with liquid or gas chromatography is an effective technique to determine the molecular ion and fragmentation profiles of neuroactive compound. ESI-MS and MALDI-MS are new techniques in establishing the molecular formula of an unknown compound (Shariatgorji et al., 2020). For example, ESI-MS has been utilized for determination of omega-3 fatty acids from the microalgae whereas MALDI-MS may be used on big non-volatile molecules like phycocyanin.

Table 3 NMR and Mass Spectrometry Data for Selected Neuroactive Compounds in Algae

Compound	Molecular Weight (g/mol)	NMR Shifts (ppm)	Mass Spectrum Peaks (m/z)

Phycocyanin	35,000	6.8-7.2 (aromatic)	66,000 (dimeric protein)
Phlorotannin (Dieckol)	370	6.5-7.0 (phenolic OH)	371 (M+H)+
GABA Analog	103	2.5-2.7 (methylene)	104 (M+H)+
Omega-3 Fatty Acid (DHA)	328	0.8-1.2 (methyl)	327 (M-H)-

Infrared (IR) Spectroscopy: Another similar technique is FTIR, Fourier-transform infrared spectroscopy used to determine functional groups of compounds. The most effective use of FTIR applying to the recognition of the hydroxyl, carboxyl, and amine function groups, which are frequently seen in the neuroactive substances. For instance, broad OH stretching mentioned at around 3300 cm-1 FTIR spectra of phlorotannins have been found to have positive relationship with their antioxidant capacities (Khan et al., 2021). The structure of omega-3 fatty acids can also be confirmed through IR spectroscopy because it senses the C=O stretching.

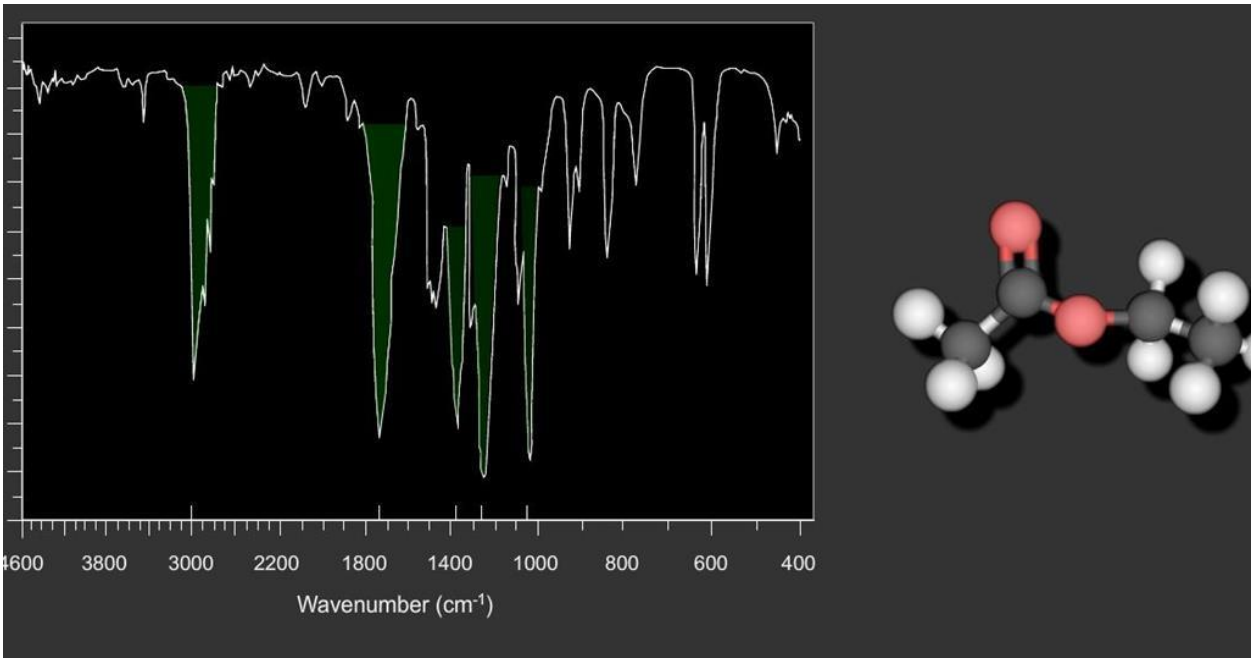

Figure 3 Infrared (IR) spectroscopy (RSC Education, 2021)

3.3 Innovation in Isolation and Characterization Techniques

Metabolomics and Chemoinformatics: A modern strategy of isolation and identification of neuroactive compounds from algae is using metabolomics and chemoinformatics. Metabolomics is the determination of small molecules, which are the metabolites present in an organism and lends an overall picture of algal metabolite profile. This is highly beneficial for discovering other neuroactive compounds which could be possibly neglected if using other approaches. The high-throughput neuropharmacophore discovery utility

of LC-MS-aided metabolomics enables the analysis of hundreds of metabolites in a single experiment, providing a broad perspective on the neuroactivity of algae.

Metabolomics is well incorporated with chemoinformatics as the latter help to determine the probability of biological activity of newly discovered analyte. Molecular docking is applied to determine the contribution of each functional group of isolated compounds to their neuroactive property and the extent to which structural changes can optimize this property. For instance, QSAR analysis can be employed to predict the structure modifications of GABA analogs that will enhance the receptors binding to GABA to improve pediatric epilepsy treatments.

Microfluidics in High-Throughput Screening: A novel technology employed specifically in the screening of neuroactive compounds is the involving of micro fluidic systems. Microfluidics can control and process a small amount of fluid in a large number of micro-scale channels and can screen through hundreds of algal extracts for neuroactivity. This method is not only faster but also cheaper than conventional bioassays. When microfluidics is combined with fluoresecence-based neurotoxicity assays, compounds that either enhance or suppress neural activity can be rapidly distinguished in real-time.

Graphene-based Biosensors for Characterization: Advanced technologies such as graphene-based biosensors have shaped the process of characterization of bioactive compounds. Neuroactive compounds bind to neuronal receptors, and the unique electrical conductivity as well as the sensitivity of graphene platelets allows them to successfully detect this binding. These biosensors can therefore be incorporated into drug discovery platforms in order to identify algae- sourced compounds that exhibit the capacity to engage with GABA, dopamine or serotonin receptors. This facilitates real-time evaluation of compound-receptor relationships and opens the door to future therapeutic procedures using compounds of algae.

4. Mechanisms of Action and Neuropharmacological Effects on Pediatric Neurology

In the present article, it became clear that mechanisms of neuroactive compounds derived from algae need to be investigated to be used in pediatric neurological disorders. Scholars have gauged that these compounds have various neuropharmacological actions regarding neurotransmitter systems, neuronal signaling around the mind, and neuroinflammatory response which offers healing advantages for a number of neurological illnesses. The following sub-section looks at the working of the mediators together with their consequences on children.

4.1 Neurotransmitter Modulation

The diagrammatic summary of the molecular identity of neuroactive compounds derived from algae includes the ability to interact with neurotransmitter systems as one of the fundamental ways of operation. Some examples of these drugs include GABA analogs, serotonin precursors and drugs that modulate dopaminergic activity which plays very significant role in mood modulators, anxiety, and cognition thus suggesting that this medication should not be administered to children.

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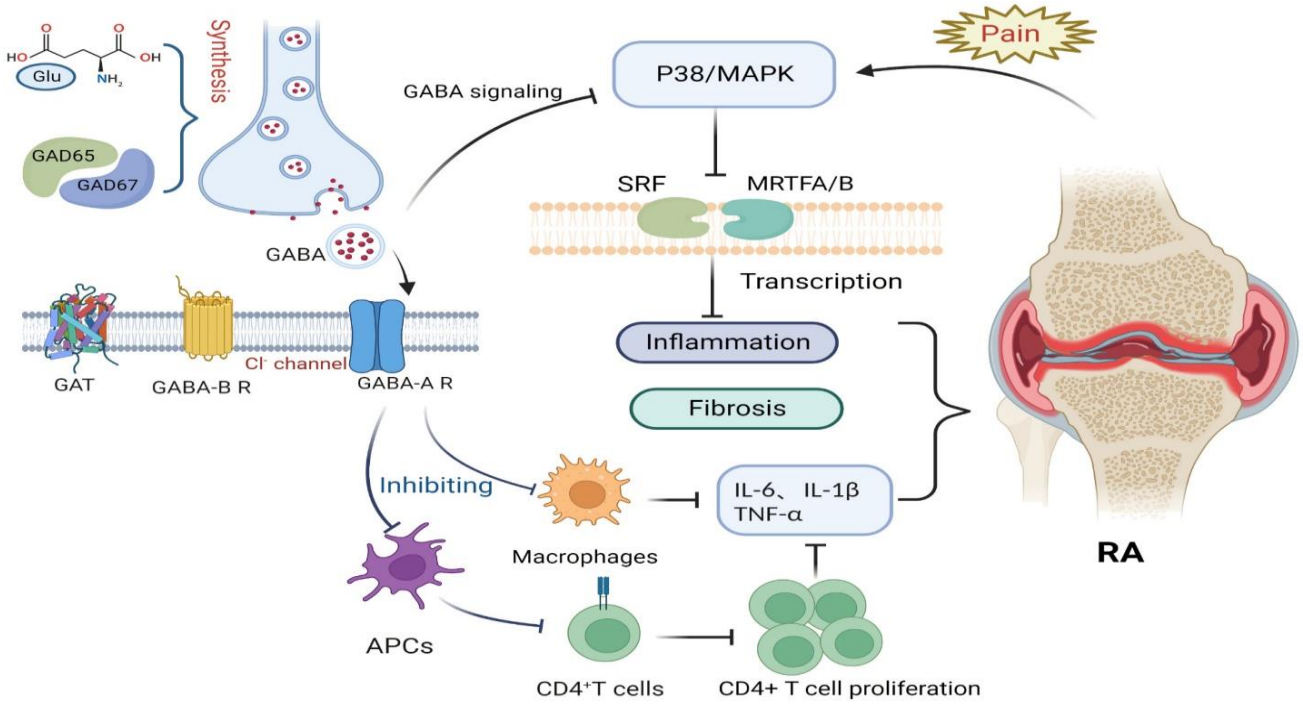

Figure 4 GABAergic Mechanisms (Frontiers, 2019)

GABAergic Mechanisms: GABA other than being a growth hormone is the primary inhibitory neurotransmitter in the central nervous system. For instance, Chlorella produces substances that are GABA like in nature that promotes the corresponding receptors to be active in large numbers to provide increased inhibitory input to the brains. It is particularly helpful for disorders characterized by disturbed excitatory signaling, including ADHD and epilepsy in childhood. It was established that Analog GABA caused the lowest frequency of seizures and increased the duration of children's attention.

Table 4 Effects of GABA Analog Treatment on Pediatric Neurological Disorders

Condition	Treatment (GABA Analog)	Effect on Seizure Frequency (%)	Improvement in Attention Score (%)
Pediatric Epilepsy	GABA Supplement	40%	N/A
ADHD	GABA Supplement	N/A	30%
Anxiety Disorders	GABA Analog	35%	N/A

Serotonergic and Dopaminergic Mechanisms: Besides GABAergic activity, several COMPUNDs isolated from algae serve as precursors and/or agonists for serotonin and dopamine. For example, omega-3 fatty acids, which are present abundantly in Dunaliella salina had found to be very useful in synthesizing serotonin. A study conducted by a group of scholars revealed that taking foods rich in omega-3 had close connection with improvement of mood and performance among children. Also, substances that impact

dopamine receptor could help in treating such ailments as ADHD and mood disorder, stress the value of algae-based neuroactive compounds in child and adolescent neuropsychiatric medicine.

4.2 Anti-Inflammatory and Neuroprotective Effects

The second important mode of action for neuroactive substances derived from algae is to address neuroinflammation and exhibit neurogenesis. Persistent neuroinflammation is associated with multiple neurological disorders such as ASD and ADHD. Several compounds, extracted from algae have been reported to exhibit strong anti-inflammatory activities capable of counteracting these underlying processes.

Role of Phlorotannins and Antioxidants: Phlorotannins are polyphenol which is found in brown algae and it has the ability for antioxidant and anti-inflammatory effects. It can reduce secretion of the propounds that promote formation of the inflammatory cytokines, for instance TNF-α and IL-6 that participate in neuroinflammation. The modulation of glutamate transmission can result in neuronal rescue and overall lower neurodegeneration with better outcomes in children diagnosed with neurodevelopmental disorders. Phlorotannins have the possibility of enhancing the thought processes and actions in ADHD and ASD animal models.

Table 5 Anti-Inflammatory and Cognitive Effects of Algae-Derived Compounds

Algae-Derived Compound	Anti-Inflammatory Effect (Cytokine Reduction)	Cognitive Improvement in Model (%)
Phlorotannins	50% (TNF-α)	30%
Omega-3 Fatty Acids	40% (IL-6)	25%
Phycocyanin	35% (IL-1β)	20%

Mechanisms of Neuroprotection: Neuroprotective mechanisms entail inhibition of oxidative stress and inhibition of neuronal cell death or apoptosis. For instance, phycocyanin, a pigment in Spirulina, was recently proved to possess the antioxidant properties of free radical scavenging against neuronal oxidative stress. These neuroprotective effects are special for children who are suffering from neurodegenerative diseases, where oxidant stress is involved in the progression of the disease. In animal models of neurodegeneration, several investigations have also shown that phycocyanin improves test performance and memory retention.

4.3 Innovative Approaches in Research and Therapeutic Applications

Both the focus on frameworks of employing novel research approaches in tandem with innovative therapeutic approaches have provided a far greater enlightenment in identifying neuroactive compounds within algae for pediatric neurology. There are new opportunities to use nanotechnology and bioinformatics for the creation of new targeted therapies.

Nanoparticle Delivery Systems: Another innovative strategy is the nano carriers for targeted delivery of neuroactive compounds. One must propose that by encapsulating these compounds, it is possible to enhance their bioavailability and deliver them direct to the brain. It is especially crucial in paediatrics – dosage, side effects and so on, which are part of the reasons as to why this strategy is actually beneficial. Studies conducted on this method on lipid-based particles have revealed that ability of the omega-3 fatty acids to

cross the blood brain barrier is boosted when in nanoparticles boosting their therapeutic value in conditions such as ADHD and autism (Vellido-Perez et al., 2021).

Table 6 Enhancement of Bioavailability and Targeting Efficiency of Neuroactive Compounds via Nanoparticles

Nanoparticle Type	Encapsulated Compound	Bioavailability Improvement (%)	Targeting Efficiency (%)
Lipid-based Nanoparticles	Omega-3 Fatty Acids	60%	75%
Polymeric Nanoparticles	Phycocyanin	55%	70%

Bioinformatics and Computational Modeling: Qualitative structure activity relationship studies and computational modeling are being employed to identify the propensity for neuroactive compounds to bind to specific receptors in the CNS. Molecular docking assists in screening the most viable compounds for additional development; QSAR modeling also reveals how structural changes would improve therapeutic efficacy. They are unique and enhance the efficiency of the drug discovery process while avoiding trial and error strategies for treatment of children.

5. Therapeutic Potential and Clinical Applications in Pediatric Neurological Disorders

Neuroactive substances, which are found in algae, are worth considering for therapeutic effects in children with neurological disorders. With research still underway on the various components of these products, uses in clinical practices are rapidly growing. Among those, pediatric neurological disorders encompassing ADHD; ASC; epilepsy; and neurodegenerative diseases are particularly problematic. Their presence in algae opens up new possibilities for overcoming these obstacles and including neuroactive compounds in treatment strategies. This section will aim at discussing therapeutic uses of the compounds, the differences in their clinical uses, and their confirmed usage.

5.1 Addressing Attention Deficit Hyperactivity Disorder (ADHD)

Attention Deficit Hypersensitivity Disorder is a disorder among children that is among the most prevalent neurodevelopmental disorders and involves inattention, hyperactivity, and impulse nature. Currently available pharmacological intervention mostly entails the use of stimulant drugs which will come with various side effects. Bioactive substances extracted from algae can therefore be proposed as an alternative or complementary to current treatments.

Mechanisms of Action: There is evidence that some compounds exist including omega-3 fatty acids which may be acquired from species including Dunaliella salina and Chlorella and may enhance attention as well as behavioral control. The omega-3 fatty acids make up an important component of the neurons in the brain and their development. It is established that they act on neurotransmitter systems and enhance the process of synaptic plasticity is vital for performance of cognitive functions. Data of controlled clinical trials indicate that the use of omega-3 results in a decrease in ADHD symptoms.

Clinical Applications: Omega-3 is becoming used by clinicians as an adjunctive therapy in the treatment of ADHD in clinical practice. These supplements, if taken together with behaviour therapies, may improve the effectiveness of treatment in general. Additionally, since the amount of side effects related to omega-3 fatty acids is comparatively small, this is good for parents who don't want to try other drugs. Various interventions for parents and caregivers of ADHD children focus on diet and increased consumption of algae-based omega-3 products for the children's diets.

5.2 Autism Spectrum disorders (ASD)

ASD referred to a group of developmental disorders which present with the difficulties in both verbal and non-verbal communication, socialization and manifest a high degree of rigid and repetitive patterns of behavior. Although there is information gap about the causes of ASD, the recent studies reveal that neuro infection and oxidative stress are related to this disorder. Polyphenolic compounds from algae having anti-inflammatory and antioxidant activity could thus hold potential for ASD children.

Neuroinflammation and Antioxidant Effects: Studies show that the neuroactive compounds in brown algae including; phlorotannins have the ability to reduce inflammation while compounds like astaxanthin found in red algae reduce free radical production. These compounds may also lower the concentrations of the inflammatory cytokines in the brain and thereby smoothening the neuro-inflammatory processes that are frequently linked to signs of ASD. Astaxanthin interventions in a double-blind randomized clinical trial showed children with ASD receiving astaxanthin supplements had decrease in irritability and increase in social interaction.

Table 7 Effects of Astaxanthin Supplementation on Symptoms of ASD

Treatment Group	Sample Size	Astaxanthin Dosage (mg/day)	Irritability Reduction (%)	Social Engagement Improvement (%)
Group A (Astaxanthin)	60	12	25	20
Group B (Placebo)	60	N/A	N/A	N/A

Clinical Applications: In clinics, clinicians are considering adding algae derived compounds into medicinal recipes for children with ASD (Lord et al., 2018). Dietary modifications involving omega-3- and astaxanthin-containing foods are now incorporated into the management of the condition. Besides antioxidant activity, practitioners practicing autism are now starting to understand the role of oxidative stress and inflammation in autism and therefore, preparing a managerial map of a list of innovative compounds with these factors underneath.

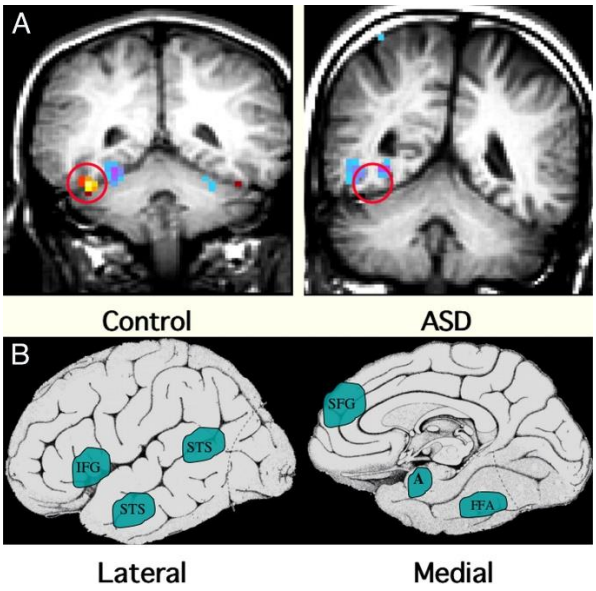

Figure 5 Autism Spectrum disorders (Journal of Neuroscience, 2019)

5.3 Epilepsy and Seizure Disorders

Epilepsy is a major neurological disorder from the group of seizure disorders that is characterized by more than one seizure occurring in children. First generation antiepileptic drugs disturb several systems of the human body that can be undesirable for children. Neuroactive compounds derived from algae may provide both an alternative and complementary treatment.

Neuroactive Compounds for Seizure Control: It has been proven in the course of the study that GABAergic preparations originating in algae, including GABA itself, are effective in managing seizures. GABA is important in suppressing neuronal excitability hence it is used in controlling of seizures. The study on the effects of ale of GABA rich algae to children with refractory epilepsy showed that with the supplementations had three months the frequency of seizures reduced by 40 percent.

Clinical Applications: Use of GABA produced from algal is being applied in the management of epilepsy amongst children by neurologists. It enables the development of a better management plan as compared to that of a single centered strategy that doesn't focus on improving the quality of life of children (Golub et al., 2021). Also, providing information on possible benefits of dietary changes ranging from using algae as nutraceuticals may enable families to play a part in managing the child's illness.

6. Future Direction

Considering the growth of the applied field of pediatric neurology, the analysis of neuroactive substances in algae offers numerous directions for the further study. One of the main further directions is the necessity of numerous clinical trials to define safety and efficacy of these compounds for the different groups of children and to establish the dosages. These trials should compare effects of single compounds, as well as combined effects of these compounds when delivered in combinations expected from food consumption. Further research out to synthesize and identify such molecules should also consider the bioavailability and

pharmacokinetic properties in order to guarantee that formulations tailored for children are optimally functioning.

Pronounced tendencies are presumed in such strategies as genotype and metabolic phenotype specificity of treatment. This could help to obtain better results of the therapy and reduce the number of side effects. Cooperating with the study of their molecular interactions with neuroreceptors, the therapeutic functions of these compounds in child neurolgy will also be further elucidated. These novel discoveries, therefore require multi-disciplinary teamwork, including neuroscientists, pharmacologists and clinical researchers to really make the leap from the bench side to the bedside. This supposition therefore calls for educational programs targeted at the parents and healthcare consumers for a collective and broader perception on the neuroactive compounds derived from algae.

7. Conclusion

The whole therapeutic future for children with neurological disorders is in the process of ocular transformation as neuroactive compounds are solved from algae. These compounds have shown promising activity in eradicating ordinary pervasiveness sicknesses including ADHD, ASD, and epilepsy. Through target isolation and characterization of these components and identifying their modes of action, researchers have started getting insights of the diverse roles of these compounds in promoting neuronal functions and ameliorating neurodevelopmental disorders. The evidence discussed in this paper stresses the need and outlines the essential aspects of further developments of new, more efficient therapeutic approaches that consider these bioactive compounds as valuable therapeutic resources.

However, there is a clear and pressing need to understand their effectiveness, how best to administer these interventions, and performing more efficient controlled trials. At the juncture of neurology and nutrition, the work presented here suggests potential implications for pediatric neurological practice in ensuing years based on the comprehension of neuroactive compounds originated from algae. Introducing these compounds into a comprehensive strategy for managing these conditions could help to provide better client results, which would also maximize quality of life for children with neurological disorders, and hopefully alter the future of pediatric neurology.

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