

Nutritional Neurosciences

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Role of Nutrients in Neurological Disorders

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Chapter 18

Herbal Remedies for Autism

Mukundan Chilambath and Geethalakshmi Sundararaman

Abstract The fundamental features of autism spectrum disorders (ASD) are long-term deficiency of interaction and social communication, repetitive behavioural patterns and impaired development. It comprises a group of neurodevelopmental abnormalities that begin in early childhood. The exact reason for autism is unclear but the immunological, genetic, psycho-social and biological factors are involved. Children with autism will be having delayed brain and body development due to lack of nutrition because of less nutrient intake and selective eating, so nutrition and balanced diet is important. The antisocial and repetitive behavioural patterns and communication disabilities can be reversed by proper education and behaviour therapy. Although there is no medicine to treat autism, risperidone is the only drug which is approved by FDA for treating children affected with autism spectrum disorders. Medicinal plants with neuroprotective effects on autism have been reported. Medicinal herbs such as *Zingiber officinale*, *Camellia sinensis*, *Piper nigrum*, *Curcuma longa*, *Bacopa monnieri*, *Glycine max*, *Prunus dulcis*, *Ginkgo biloba*, *Arthrospira platensis* and *Chlorella vulgaris* have been claimed for neuroprotective effects and might be useful in treating the problems associated with autism spectrum disorders. Herbal medicines are promising treatment or remedies for reducing symptoms of autism and improving memory, cognition and behaviour.

Keywords Autism · Neuroprotective effects · Medicinal herbs · Risperidone · Cognition

18.1 Introduction

Brain is the most vital organ in the human system and is the central organ of nervous system. It acts as a command and control system of body. It regulates the voluntary activities, balancing of body and functioning of other important involuntary organs

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of body. Also it regulates the body temperature, digestion, hunger, thirst, activities of endocrine glands and human behaviour. Brain processes the vision, hearing, speech, memory, intelligence and emotions and thoughts. As brain is a vital organ in human body with numerous functions, any disorders affecting brain may result in improper functioning of body and internal organs. Thus the brain should be supplied with vital nutrients which are essential for effective functioning of the body.

18.1.1 Autism

Autism is commonly a brain-based disorder which is strongly genetic in nature. **Autism or autism spectrum disorders (ASD)** is defined as a broad range of neurodevelopment disorders characterized by challenges with social skills, repetitive behaviour, speech and nonverbal communication and impaired social functioning. Several types and subtypes of autism are there, affecting children, most influenced by combination of environmental and genetic factors.

People with autism have trouble with communication and in understanding the feelings and thinking of others. Thus it makes them hard to express their feelings and expressions through words, gestures, facial expressions and touch. Also they have problems with learning and the development of various skills in them might be in an uneven pattern. This could be trouble in communications skills but be unusually good at music, arts or any other specific skills (Bahmani et al. 2016).

18.1.2 The Brain and ASD

Children affected by autism have excess synapses and connections between the brain cells. This is mainly because of the lack or sometimes sudden shutdown of the normal pruning process that occurs during brain development. A typical pruning process will be happened in an individual at late adolescence, which is actually the elimination of about half of the cortical synapses. Cortical synapses are found in the cerebral cortex, which plays a vital role in receiving and processing the information from various senses. Some children affected by autism are seen to be having a larger brain than normal. However, the role of brain in autism is not clearly understood.

Neuroimaging studies in ASD shows the abnormalities in different parts of brain such as frontal cortex, cerebellum, hippocampus and cerebello-thalamo-cortical pathways in autistic patients. One of the ASD studies' findings are presence of focal cortical dysplasia due to the heterochronic division of germinal cells leading to abnormal migration of the daughter cells to their target regions. Abnormal neuronal migrations lead to the circumscribed foci of thin cortical area of ASD brain especially in frontal lobe which contains smaller pyramidal neurons and interneurons. These findings attribute the sensory and motor deficit and impaired functions in ASD patients. The increased size of brain in autistic children is due to autism-epilepsy or

autism associated with macrocephaly, which is a condition of accelerated brain growth in early developmental stage.

18.1.3 Symptoms and Signs of Autism

- Lack of eye contact.
- A narrow range of interests and showing more interest in certain topics.
- Highly sensitive to sounds, touches and smells.
- Not looking and listening to other people.
- Doing certain tasks or activities over and over. Repeating certain words or phrases and rocking back and forth.
- Abnormal tone of voice.
- Learning disabilities and deficit in language comprehension.
- Lack of empathy and self-abusive behaviour.
- Affected children will not smile or laugh in response to others' activities (Klein and Kemper 2016).

18.2 Pathophysiology of ASD

The pathophysiology of autism spectrum disorders involves the defects in several genes and most of them are involved in neuronal synaptogenesis. Along with these genetic factors, many environment factors, associated conditions such as gastrointestinal (GI) abnormalities and immune balance are also the pathophysiological conditions of ASD. Although there is a strong genetic base for ASD, several other factors could have direct link and impact to the pathogenesis of ASD. In many children, these external factors act as modifying factors of these genes in aggravating the disorders.

Many children affected by autism have GI problems such as abdominal pain, chronic diarrhoea, constipation, vomiting, gastro-esophageal reflux, intestinal infections, etc. The gastrointestinal tract is having a direct connection with immune system of body; mucosal layer and Peyer's patches on GI tract have profound effect on immune responses and reactions. Thus children suffering from ASD will be having immune response imbalance due to gastrointestinal problems.

Immune system imbalance is also a condition seen in ASD due to the neuroinflammation; it causes abnormalities in activating microglial cells and innate neuroimmune system. Because of the neuroinflammation, immune dysregulation and increased inflammatory cytokines in brain alter the structure and functions of blood–brain barrier (BBB) causing imbalance in brain metabolism and dysregulation of brain homeostasis. Along with this, maternal infections and autoimmune disorders also cause immune imbalance in ASD patients (Brondino et al. 2015).

18.2.1 Genetic Factors

Genetics also plays a major role in autism. Autism occurs more frequently in patients and in certain families with some other genetic disorders such as fragile X syndrome, tuberous sclerosis, congenital syndrome and untreated phenylketonuria. There is not a single gene, which is responsible for autism but there tends to be a pattern of autism and other genetic disorders in families. Some children are born susceptible to autism spectrum disorders and the factor which triggers it to cause autism is unknown.

Even though the exact pathophysiological mechanism of autism is unknown, it is evident from several studies that genetic factors have a great impact on the aetiology of ASD. For instance, tuberous sclerosis, fragile X syndrome and Rett syndrome are some conditions which are associated with ASD. It is also seen that the siblings and twins of autistic children have a higher chance of getting autism. Thus, it says the strong role of inheritance of autism. There is a wide range of phenotype but more genetically homogeneous ASD patients present are with less phenotypic heterogeneity. It was found that the de novo copy number mutations and rare variant mutations which is resulting in abnormal alleles in the affected person or close ancestry that influence neuroanatomical and behavioural traits. This is because of the dysregulation in genes which are involved in synapses functions. It is also evident from studies that the abnormal combination or structure of several transmembrane and scaffolding proteins involved in synapsogenesis and its maintenance, dysregulation of genes involved in signal transduction mechanism of synapse formation, which are some of the common and major genetic abnormalities of ASD.

The mutations in mitochondrial DNA also have a role in ASD, because several neurological disorders are having a condition of mitochondrial dysfunction. Mutations in mitochondrial DNA lead to impairment of energy metabolism. Mitochondria itself has antibacterial immunity and if mitochondrial dysfunction happens due to mutations, it leads to greater GI tract infections in autistic children (Bastaki et al. 2020).

18.2.2 Non-genetic Factors

The exact reason or causes of autism spectrum disorders are unknown, but majorly autism features abnormalities in brain structure or functions. Non-genetic factors are also having a great impact in the aetiology of ASD. It is evident that gastrointestinal problems such as abdominal pain, constipation, diarrhoea and vomiting are seen in autistic patients due to GI infections and gut leaks. Due to leaky gut or intestinal epithelium, the gluten and casein or digested products leak out to the bloodstream, which causes immunogenic response in brain. Thus GI abnormalities are very common in autistic children which affects the gut-brain interaction and thus leads to pathogenesis and severity of ASD (Mulloy et al. 2010). Apart from this, several other factors like stress, inflammation, toxins or drugs like valproic acid or

Fig. 18.1 Structure of valproic acid

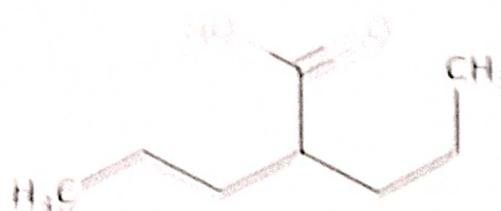
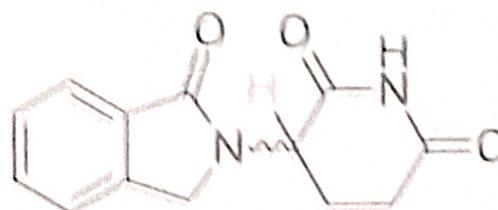


Fig. 18.2 Structure of thalidomide



thalidomide and even infection exposure during pregnancy may also increase the risk of autism spectrum disorders in children (Theoharides and Asadi 2012) (Figs. 18.1 and 18.2).

18.3 Screening and Diagnosis of ASD

Early diagnosis of autism spectrum disorders in children is very difficult as it does not have any medical tests to diagnose. Many children are not diagnosed early because ASD ranges from mild to severe and this may cause delay in treatment for years. The following are the common methods used in diagnosis of autism in children (Filipek et al. 1999; Kabot et al. 2003; Sharma et al. 2018).

- **Developmental Screening:**

Developmental screening is an efficient test in diagnosing autism, in which a paediatrician would be testing the learning skills of a children and observing the learning process, speaking skills, behaviour and movements.

- **Observation of Speech problems:**

This helps in the evaluation of speech and hearing developments in child. During this test, doctor will be observing how a child respond and react to the parent's smile, voice and activities. The communication skills are also observed here.

- **Evaluation of Social skills:**

Determining the social skills is very important in diagnosing autism. Children with autism are not able to look into others' face or eyes. They do not communicate without expressions and gestures and repeating certain words. This evaluation helps in finding of children's communication, gross motor, fine motor, problem solving and personal adaptive skills.

- **Comprehensive Diagnostic Evaluation:**

A comprehensive diagnostic evaluation helps in diagnosing children with autism by observing child's behaviour, development and by interviewing parents.

Screening of vision, speech, communication, genetic screening and neurological testing.

ASD is diagnosed in children early by evaluating the impairment in social interaction, communication and a restricted and repetitive behavioural patterns, interests and activities (Page 2000).

18.4 Treatment for ASD (Pellow et al. 2011; Sze and Wood 2008; Akins et al. 2010)

18.4.1 Behaviour Programmes

Behavioural therapy programmes are offered by several government organizations to help people in improving communication, social interaction with other people, positive reinforcement and social training for improving behaviour and communication.

Applied behavioural analysis (ABA) and Treatment and education of autistic and related communication handicapped children (TEACCH) are treatment available for children affected with autism.

18.4.2 Education

Educating children with autism spectrum disorders is also a better mode of treatment for improving their skills and various abilities. The individuals with disabilities education act (IDEA) determines about providing of education to children affected by autism.

18.4.3 Medications

Although there is no proper treatments or medication for autism spectrum disorders, there are treatment for symptoms of autism.

Medications and therapy should be given under the proper advice of a paediatrician. Antipsychotic agents such as risperidone, aripiprazole and drugs such as methylphenidate, fluoxetine, anti-seizure medications are used commonly (Calarge et al. 2014).

18.4.4 Sensory Integration

Children with autism are very much sensitive to external stimuli such as sound, texture, taste, odours, etc. Some children may become agitated by touching, hearing or seeing certain things, tasting certain tastes and smelling certain odours. Training to adapt to these may improve behaviour.

Sensory integration therapy assesses how an autism affected child's brain is processing various sensory inputs. A physiotherapist or an occupation in this field evaluates the autistic children and creates a plan which matches the sensory stimulation and physical movement, which can improve the brain in processing and organizing sensory information.

18.4.5 Assistive Technology

This type of treatment involves use of technology in improving nonverbal, communication disabilities and functional incapability of severe autistic children. It involves the use of computer, mobile or any mobile applications with programmes designed to engage children with autism. Children with severe communication disabilities and hearing impairment can be treated using technology to improve their communication skills.

18.4.6 Balanced Diet

A balanced diet and supplementation of vitamins is advised and prescribed by clinicians for autistic children. Improvement in symptoms is seen in autistic children who are given with a proper balanced diet. Some autistic children show symptoms such as constipation and habit of eating in an unusual manner. These symptoms can be reduced by a keeping a proper diet.

Children with autism may have an allergy or high sensitivity to food containing gluten or casein. Autistic children's body processes peptides and proteins in food containing gluten and casein in a different way than other people. Thus gluten-free, casein-free (GF/CF) diet is provided for children with autism. The diet eliminates all gluten containing food (wheat, barley, etc.) and casein (milk and dairy products).

Benefits of GF/CF diet are improved social interaction, improved speech and language, decreased self-injurious and antisocial behaviour, improved focus and awareness, and increased immune function (Johnson 2006).

18.5 Treatment and Herbal Remedies for Autism Spectrum Disorders Treatment

Although no specific medicines has been recognized to treat autism, risperidone is the only drug approved by the FDA used in children affected with autism spectrum disorders. Other pharmacological treatment methods are adopted to reduce the signs and symptoms such as sleeping disorders, self-abusive and harmful activities, repetitive behaviour, etc. Plants having neuroprotective effects on autism have been recognized and can be used as herbal remedies for autism (Sharma and Chouhan 2016; Saki and Nadari 2018; Selvakumari et al. 2021). Complementary alternative medicine therapy (CAM) is the most effective treatment method for autism. They are of two types:

- Biologically based CAM.
- Non-biologically based CAM.

18.5.1 Biologically Based CAM Treatment

(a) **Balanced diet**

One of the popular and effective treatment method is the elimination diet, that is the gluten-free, casein-free (GFCF) diet as gluten and casein protein may originate opiate-active metabolites in the gut that could reach the systemic circulation because of gastrointestinal problems in ASD. In addition to this, low carbohydrate, high fat-ketogenic diet is administered to children with refractory epilepsy, this dietary regimen determines a better seizure control and has an effect much comparable to antiepileptic drugs.

(b) **Vitamins**

Vitamin supplementation is another CAM therapy for ASD. Dietary deficiency of important vitamins and micronutrients is observed in autistic children. It has been reported that autistic children are introduced with vitamin-D, K, A, E and vitamin B6 in lesser than recommended amount. These deficiencies are resulting in food selectivity and altered gastrointestinal absorption. This can be reduced to great extent by providing proper vitamin and nutrient supplementation (Rezapour et al. 2016).

(c) **Nutraceuticals**

Nutraceuticals are food substances which provides good health and medical benefits including disease prevention and treatment. It consists of dietary supplements such as vitamins, minerals, amino acids, etc. Providing nutraceuticals is a potential treatment for autism with limited and no side effects (Brown and Patel 2005).

18.5.2 Non-biologically Based Treatment

The National Center for Complementary and Alternative medicine (NCCAM) categorizes the non-biologically based CAM therapy into three Categories. They are:

(a) Mind-body medicine

Prayer, yoga, music, dance, meditation and arts

(b) Manipulative and body based practices

Acupuncture and massage

(c) Energy medicine

Homoeopathy

18.6 Herbal Remedies

The trend and practice of usage of medicinal plants as a source for preparation of new drugs for treating various diseases are emerging. Medicinal plants are herbs which contain active compounds or ingredients in their tissues and are effective against a wide range of diseases. Medicinal herbs used as medicinal source for preparation of drugs are available, effective and inexpensive. It is having a very fewer or no adverse effect than a chemical drug or compound. Different medicinal plants have different properties and various active compounds in them which are having effect on human body (Bang et al. 2017; Mourão-Miranda 2018; Selvakumari et al. 2021).

Recently, it was found that certain medicinal plants can be used for treating autism spectrum disorders. The neuroprotective activity of phytochemicals in plants is having a promising effect on autism (Al-Askar et al. 2017).

18.6.1 Ginger (*Zingiber officinale*)

Zingiber officinale Roscoe (Ginger) belongs to the family Zingiberaceae, is one of the spices which is frequently used. It is extensively used in traditional medicine to treat various diseases including gastrointestinal and digestive problems. The components present in ginger are gingerols, zingerone, parasols and shogaols. Ginger shows a wide range of pharmacological properties like anti-inflammatory, anti-cancer, anti-allergic, anti-diabetic, analgesic, anti-hypertensive, antioxidant, immunomodulator activity, neuroprotective activity, memory enhancing activity and many other. Ginger may also be used to treat autism and antisocial behaviour of autistic children.

The gut microbiota in organisms are having a potential to change the brain and behaviour. It signs in autism and other neurological disorders. These gut microbiota produce propionic acid as a secondary product which is commonly used as food

preservatives. The infusion of propionic acid into veins induces repetitive dystonic behaviour, excessive movements, turning behaviour and retropulsion. Several social interaction studies were conducted in mice using ginger extracts and it was observed the activity of ginger against propionic acid induces social behaviour impairment. The neurodegeneration, change in neuronal cell integrity by the interference with propionic acid was resulted in antisocial behaviour and behavioural changes. This type of propionic acid induced social impairment can be treated using ginger as it is having protective effects against it. Thus ginger may be included in treatment strategy of autism spectrum disorders (Parashar and Udayabanu 2016; El-Ansary et al. 2018).

18.6.2 Flavonoids in *Camellia sinensis* (Tea Plant)

In ASD patients, higher levels of oxidative stress are seen. The autism patient's exposure to various environment pro-oxidant factors including pharmaceutical compounds such as valproic acid, heavy metals, air pollutants and toxins of bacteria or viruses are involved in triggering oxidative stress in them.

It is evident from different studies that green tea therapy using *Camellia sinensis* is effective in decreasing oxidative stress. This plant is a major dietary source of polyphenol- flavonoid. Catechins such as epigallocatechin-3-gallate, epigallocatechin, epicatechin-3-gallate and epicatechin are the flavonoids present in *Camellia sinensis*. It also contains gallic acid, chlorogenic acid, caffeic acid and flavanol derivatives such as kaempferol, myricetin, quercetin, etc.

18.6.3 Pepper (*Piper nigrum*)

The active phytochemicals in *Piper nigrum* have effect on behavioural alterations and oxidative stress in autistic patients. Piperine is the major alkaloid present in *Piper nigrum* which shows antioxidant, neuroprotective and cognition enhancing effects. The oxidative stress and behavioural impairments can be reversed by piperine in autistic patients. A study on amelioration effects of piperine in behavioural alterations reveals that piperine treatment restores the motor deficit and decreases the reorientation time due to its ability to cure cerebellar damage, which is a condition of autism spectrum disorder.

18.6.4 Turmeric (*Curcuma longa*)

Turmeric (*Curcuma longa*) is an Indian spice of ginger family Zingiberaceae. Turmeric is well known for its protective action against neurodegenerative diseases

and neuropsychiatric disorders. It is because of the presence of chemical compounds called curcuminoid. Curcumin (Diferuloyl methane) is the major curcuminoid present in turmeric which is a nontoxic molecule, able to cross blood–brain barrier (BBB). It is also reported to have positive effects on the treatment of autism as curcumin targets several cell signalling pathways. Curcumin is also having effects on increasing the intracellular level of glutathione, reducing inflammatory components, mitochondrial dysfunction, oxidative stress and protein aggregation, counteracting against tissue damages which are caused by heavy metals and it helps in liver detoxification.

Altered brain shape and structure is a sign of autism in children. It is due to the brain toxicity and delayed maturation of brain. These alterations can be reversed by curcumin. It also helps in improving abnormal brain weight and delayed maturation. Oral administration of curcumin restores the neurological, behavioural, biochemical and molecular changes happening in autism spectrum disorders. As such curcumin can be developed as a neuro-psychopharmacotherapeutical drug because of its characteristics and potential effects for ASD treatment (Lopresti 2017; Bhat et al. 2019).

18.6.5 *Bacosides in Brahmi (Bacopa monnieri)*

Bacopa monnieri, commonly called as brahmi is a medicinal plant widely used in improving cognition and memory formation. Bacosides, the medicinal substances are the main bioactive compounds extracted from brahmi plant, which is widely used by Indian tribes. It is evident that supplementation with bacosides has been shown to improve cognition, by reducing anxiety and also in improving memory formation. Neuron communication is promoted by bacosides as it is able to interact with neurotransmitter, dopamine. It does this by enhancing the rate at which the nervous system can communicate by increasing the growth of nerve endings called dendrites. The major bioactive compounds found in *B. monnieri* are two triterpenoid glycosides denoted as bacoside A and bacoside B. Both the bacosides are able to improve cognition and memory formation. Pharmacological effects of this plant are attributed to the number of alkaloids, saponins and sterols present in it. It has been reported that bacosides modulate cholinergic densities along with acetylcholine levels, and also in presence of these compounds, the central nervous system shows beta-amyloid scavenging properties and anxiolytic relieving process. Although its biological molecular mechanism is not proven, it is known that these bacosides increase certain brain chemicals involved in thinking, learning, memory and also protect brain cells from toxic chemicals substances.

18.6.6 Soybean (*Glycine max*)

Individual with autism spectrum disorders consume inadequate levels of vitamins and minerals related to selective eating, decreased gut absorption, depletion of nutrients and increased needs of nutrients. The deficiency or low intake of vitamins and minerals is mainly caused by restrictive diets. Children with ASD are characterized with sensory processing disorder (SPD) which is a condition in which the brain is unable to receive, process and to respond to the information that comes in through various sensory organs. Eating is a very sensory rich activity which includes all the senses at once and this can be very overwhelming for autistic children with SPD. This nutrient deficiency causes additional cognitive and behavioural issues. To balance the nutrition, a diet rich of vitamins and minerals is needed. Soya bean (*Glycine max*) is a species of legume which is rich in vitamin B6, vitamin B12, etc. It is recommended that autistic patients use magnesium-rich food like soya bean, which is also rich in selenium (Woolf 2003).

18.6.7 Essential Fatty Acids (Vegetables, Seeds and Nuts)

Because of the restricted diets and selective eating, ASD patients have less intake of essential fatty acids such as omega-3 fatty acid resulting in many behavioural and cognitive issues. Omega-3 fatty acid is vital for cognition and brain health. A low level of this fatty acid may cause brain fog, lack of concentration, slow language development, delay in brain development and other cognitive impairment.

Supplementation with omega-3 fatty acid is helpful in improving cognition and brain development. Fish oil is rich in essential fatty acids including high amount of omega-3 fatty acid. A dose of double the dietary reference intake (DRI) is an adequate dosage for children with ASD (1200–1600 mg for children ages 9–14). Some plants are also excellent sources of omega-3 fatty acids. Autistic patients can consume vegetables, seeds and nuts which are rich in omega-3 fatty acids to meet the recommended quantity. ALA, DHA and EPA are the major 3 types of omega-3 fatty acids. Algae such as spirulina and chlorella are important sources of omega-3 fatty acids, they contain DHA and EPA. Chia seeds are very good source of ALA omega-3 fatty acids. Kidney beans, soybeans and walnuts are other best plant sources of ALA omega-3 fatty acids; they are also rich in riboflavin, folate, magnesium, potassium, etc.

18.6.8 Ginkgo (*Ginkgo biloba*)

Ginkgo (*Ginkgo biloba*) is the only living species in the Ginkgophyta division. It is an herb used to treat memory loss, cognitive disorders, glaucoma, dementia, and as a

Table 18.1 Medicinal herbs used for autism treatment and their effects

Common name of plant	Scientific name	Effects
Ginger	<i>Zingiber officinale</i>	It has effects like neuroprotective and immunomodular activities which improves neurological functions, cognition, memory and reduces antisocial behaviours
Tea plant	<i>Camellia sinensis</i>	Taking green tea therapy reduces oxidative stress as it is an antioxidant
Pepper	<i>Piper nigrum</i>	Antioxidant, neuroprotective, anxiolytic and cognition enhancing effects
Turmeric	<i>Curcuma longa</i>	Protecting from neurodegeneration and involved in cell signalling pathways
Brahmi	<i>Bacopa monnieri</i>	Improves memory, thinking, learning, communication and cognition
Soya bean	<i>Glycine max</i>	Rich in magnesium, selenium, vitamin B6 and B12. Supplement nutrients
Almond (badam)	<i>Prunus dulcis</i>	Provides recommend vitamins B12 and B6 for autism patients
Ginkgo	<i>Ginkgo biloba</i>	It affects neurotransmitter system and reduces the symptoms and aberrant behaviour in ASD
Algae—Spirulina Chlorella	<i>Arthrospira platensis</i> <i>Chlorella vulgaris</i>	Rich in omega-3 fatty acids, recommended for cognitive and behavioural impairments

vasodilator. As it is effective in reducing cognitive disorders and in improving memory, its extracts are being used in autistic patients. The components isolated from *Ginkgo biloba* extract contain terpenes, flavonoids, alkyl phenols, carboxylic acid, polyphenols, etc. Pharmacological studies say that Ginkgo flavonoid glycosides are predominantly responsible for its antioxidant activity. It reduces the oxidative stress induced by reactive oxygen species, which contributes to the neurodevelopmental disorders caused by membrane damage, change in DNA structure and damage, degradation of lipids, etc. Terpene trilactones present in Ginkgo are associated with the neuroprotective properties which aids in resolving the pathogenesis of autism (Table 18.1).

18.7 Conclusion

Autism spectrum disorders are recognized as neurological disorder with pervasive developmental disabilities in which no specific drug or treatment is available. As there is no medicine for treating autism, a treatment strategy including herbal medicines, education and behaviour therapy combined with balanced diet would be a great method of treating autism, which might be useful in reversing the behavioural patterns and improving cognition, social interaction and

communication. Numerous researches and studies are undergoing for treatment of autism in which herbal sources are resulting as a successful and prominent treatment method with less or no side effects.

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