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Review

AUTISM: PLANTS WITH NEURO-PSYCHOPHARMACOTHERAPEUTIC POTENTIAL

Mustafa Sevindik[1], Falah Saleh Mohammed*[2], Imran Uysal[3]

[1] *Department of Biology, Faculty of Science and Literature, Osmaniye Korkut Ata University, 80-000 Osmaniye, Türkiye.*

[2] *Department of Biology, Faculty of Science, Zakho University, 42-001 Duhok, Iraq.*

[3]*Department of Food Processing, Bahçe Vocational School, Osmaniye Korkut Ata University, 80-000 Osmaniye, Türkiye.*

* Correspondence, e-mail: falah.sindy@uoz.edu.krd

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ABSTRACT

In recent years, there has been an increasing prevalence of cases of autism. There is no general cure for autism; however, there are situational treatments available. In this context, plants may be beneficial in suppressing the conditions that may arise in the disease. This study compiles plant species that have been reported in the literature as potential remedies for autism disorders. Furthermore, the general characteristics, usage areas, and biological activities of these plant species have been compiled. As a result of our research, it has been seen that plants can be used to combat many symptoms of autism. It is believed that plants may contribute to the improvement of the well-being of individuals with autism, as a result.

KEYWORDS: autism, medicinal plants, pharmacotherapeutic, complementary medicine.

1. Introduction

Traditional and complementary medicine refer to a series of treatment methods that have their roots in earlier times, predating modern medicine [1,2]. The active ingredients of many drugs used in modern medicine are obtained directly from natural products or synthesized through the synthetic production of compounds found within natural products [3,4]. Numerous natural products such as fungi, plants, and animals are utilised within the scope of traditional medicine [5,6]. Natural products that are noteworthy for their nourishing properties are plants. They are consumed in many meals of the human diet [7]. In addition to their nutritional properties, plants have been used by humans for years in the fight against diseases [8]. Plants possess numerous medicinal properties due to the presence of bioactive compounds within their cells [9]. Numerous studies have reported that plants exhibit various biological activities such as anticancer, antimicrobial, anti-inflammatory, antioxidant, anti-aging, hepatoprotective and DNA protective activities [10-19]. It can be observed within this context that plants are highly significant natural resources. This study compiles the research conducted on plants used in the treatment of autism as reported in the literature. Furthermore, the general characteristics and other activities of plants used in autism have been compiled.

2. Autism and plants used in alternative therapy

Autism Spectrum Disorder (ASD) is a comprehensive behavioural disorder that affects the social interaction and communication of individuals throughout their lives, starting before the age of three. It is characterised by restricted and repetitive behaviours that limit the use of brain functions. [20] These symptoms differentiate autism particularly from Asperger's syndrome. According to the classification of autism spectrum disorders, Asperger syndrome is a milder form of behavioural disorder [21]. While the incidence of autism spectrum disorder was considered to be 1 in 500 in previous years, according to recent data, autism spectrum disorder is thought to affect approximately 1 in every 54 children. In addition, its prevalence in boys is 4.3 times higher than in girls [22]. Recent research on the mechanism of autism focuses on subcortical-mediated social orientation status, differences in electroencephalography (EEG) and other measures of brain function, and brain changes in synaptic signaling pathways. Among these recent studies, it is thought that especially defects in synaptic protein, changes in synaptic structure, function and neural circuits constitute the mechanism of autism spectrum disorder. It is also stated that synaptopathy is an important component of autism [23].

Autism has a genetic origin. However, despite varying

perspectives, the precise details of genetic factors cannot be fully elucidated. There are opinions suggesting that birth-related disabilities, vaccinations administered at a young age, and illnesses may lead to autism in later years [24]. In recent years, there has been a significant increase in the incidence of autism cases. Although the general cause of this remains unclear, the lack of knowledge regarding the former prevalence and changes in diagnostic methods have resulted in unknown ratios of cases prevalence in the past and presently. Autism affects different regions of the brain. Furthermore, it remains uncertain how it affects the regions it impacts [25]. Parents can diagnose the illness of their children based on symptoms during their early years. Early diagnosis can reveal the potential for behavioural or cognitive interventions in later stages of life, which may enable patients to improve their self-care and social communication abilities. Furthermore, it has been suggested that individuals with autism spectrum disorders may experience a reduction in symptoms as they reach adulthood, allowing them to achieve greater independence [26]. The diagnosis of autism is based on a series of symptoms rather than a single indicator. Symptoms such as social withdrawal, communication impairments, avoidance of contact, hyperactivity, limited attention, repetitive behaviours, and eating disorders have been identified [27]. Autism is perceived to operate through two processes. The pathophysiology of brain structures and processes is linked to the neuropsychological connections between brain structures and behaviours. There is no fundamental treatment method for autism. Treatment is typically administered based on requirements. Early intensive and continuous educational programmes, as well as behavioural therapies, have been shown to promote children's self-sufficiency in later years [28]. Many drugs are used in the treatment of autism. Often after diagnosis, more than half of the cases are children using psychotropic drugs. The most common classes of these medications are antidepressants, stimulants, and antipsychotics. In addition to these, alternative treatment methods are also being applied [29]. The methods of treatment are typically costly. For this reason, individuals utilise natural products that are used in complementary or alternative medicine.

In this study, plant species used in autism in the literature were compiled. The obtained results are shown in Table 1.

Table 1. Plants used in autism [30-62].

Plant species	Family	Used Parts	Geographic regions	Effect
Acorus calamus	Acoraceae	Stem	Iran, Germany	Neurotransmitter function
Centella asiatica	Apiaceae	Aerial	Iran, Germany	Neurotransmitter function
Asparagus racemosus	Asparagaceae	Stem	India	Oxidative stress suppressor
Lepidium sativum	Brassicaceae	Seed	Saudi Arabia	Nutritional supplement
Lobelia inflata	Campanulaceae	Aerial	Iran	Neurotransmitter function
Cannabis sativa and *Cannabis* spp.	Cannabaceae	Aerial	USA, Israel, Italy	Neurotransmitter function, communication enhancer, cognitive enhancer, behavior controller, gastrointestinal system regulator, sleep regulator, sedative, appetite regulator
Ginkgo biloba	Ginkgoaceae	Aerial	India, Iran, Egypt, Germany, Italy	Neurotransmitter function, regulating social behavior deficiencies, regulating behavior problems
Astragalus membranaceus	Leguminosae	Aerial	Iran, Turkey, China, Germany	Neurotransmitter function
Glycine max	Leguminosae	Seed, aerial	India, USA	Nutritional supplement, antitiroid effect
Salvia spp. and *Salvia officinalis*	Lamiaceae	Aerial	Burkina Faso, Egypt	Anxiolytic, antidepressant, regulating social behavior deficiencies, neurotransmitter function
Moringa oleifera	Moringaceae	Seed	Egypt	Gastrointestinal system regulator
Paeonia lactiflora	Paeoniaceae	Stem	Iran	Neurotransmitter function
Passiflora incarnata	Passifloraceae	Aerial	Iran	Oxidative stress suppressor, behavior controller
Piper nigrum	Piperaceae	Aerial	India	Oxidative stress suppressor
Bacopa monnieri	Plantaginaceae	Aerial	India	Communication enhancer, cognitive enhancer, neurotransmitter function
Actaea racemosa	Ranunculaceae	Stem	Iran	Neurotransmitter function
Camellia sinensis	Theaceae	Aerial	India, Indonesia, Venezuella	Oxidative stress suppressor, neurotransmitter function
Zingiber officinale	Zingiberaceae	Aerial, stem	India, Saudi Arabia, Iran, England, Germany	Neurotransmitter function, cognitive enhancer, memory booster, reduces antisocial behaviours
Curcuma longa	Zingiberaceae	Aerial, stem	India, Australia	Protecting from neurodegeneration, cell signaling modifier, neuro-psycho-pharmacotherapeutic

2.1. *Zingiber officinale*

Zingiber officinale Roscoe, commonly known as ginger, is a botanical species widely recognised among the general population. This plant is a perennial herb. The general distribution area is the Southeast Asia region. However, it is being propagated and multiplied by being incorporated into cultures in many regions of the world. The height can reach up to one metre. Ginger has various applications in terms of both pharmacology and flavour [63]. It has been reported that ginger possesses various biological activities such as antioxidant, anti-inflammatory, antimicrobial, cytotoxic, neuroprotective, cardiovascular-protective, antiobesity, antidiabetic, antinausea, and antiemetic effects [64,65].

When examining the impact of ginger on autism, research conducted in Germany, the United Kingdom, Saudi Arabia, Iran, and India has investigated the effect of the *Z. officinale* plant's spice properties on children with autism. Many studies have reported that ginger is effective against propionic acid, which causes behavioral disorders [30-35].

2.2. *Acorus calamus*

The plant *Acorus calamus* L. is known by various names, including cinnamon sedge or sweet cinnamon. The nomenclature of this plant includes various names such as sedge, sweet sedge, flag root, gladdon, myrtle grass, myrtle sedge, sweet myrtle, myrtle flag, sweet root, sweet cane, and sweet rush. This is a long-standing aquatic plant. The distribution areas encompass India, Russia, Japan, the USA, China, Sri Lanka, and Burma. The use of bay leaves has enabled the substitution of ginger, cinnamon, and coconut in culinary applications. The areas of application encompass both nutritional and pharmacological fields. Particularly in the field of health, fever, toothache, nerve pain, and digestive problems are among the most prevalent conditions [66,67]. It has been reported that *A. calamus* possesses various biological activities such as antimicrobial, antioxidant, insecticidal, cytotoxic, anti-inflammatory, anticholinesterase, antitumor, and analgesic properties [68,69].

2.3. *Actaea racemosa*

The plant *Actaea racemosa* L. (*Ranunculaceae*) is commonly known as black cohosh among the general population. The general distribution area is North America. Due to its pharmacological properties, it is widely used. Among conditions it is used for are menopause, irregular menstrual cycles, and neural problems [70,71]. It has been reported that *A. racemosa* exhibits various biological activities such as antioxidant, antiestrogenic, anticancer, cytotoxic, and antimicrobial effects [72].

2.4. *Lobelia inflata*

Lobelia inflata L. is also known as Indian tobacco or emetic weed. Typically, it is an herbaceous plant that lasts for one or two years. The stems are typically hairy, the leaves are oval and serrated, and the flowers bloom in mid-summer. Remedies for muscle disorders and respiratory problems, and laxative use are among the health-related applications of *L. inflata*. Apart from the healthcare sector, incense and insecticides are also used in religious ceremonies [73-75]. It has been reported that *L. inflata* exhibits various biological activities such as antimicrobial, anti-inflammatory, antitumor, antidepressant, and antioxidant properties [76].

2.5. *Paeonia lactiflora*

Paeonia lactiflora Pall., commonly referred to as the Chinese peony, Chinese herbaceous peony, or common garden peony, belongs to the family *Paeoniaceae*. *P. lactiflora* is a perennial plant that is characterized by its showy and floral appearance. Asia ranks first in terms of general distribution area. In the field of healthcare, it is used for conditions such as dysmenorrhea, rheumatoid arthritis, cramp pain, hepatitis, muscle pain, and systemic lupus erythematosus [77-79]. It has been reported that *P. lactiflora* exhibits various biological activities such as anti-inflammatory, cytotoxic, antimutagenic, antitumor, antioxidant, antimicrobial, and hepatoprotective effects [77, 80].

The effects of *A. calamus, A. racemosa, L. inflata* and *P. lactiflora* on autism within the scope of a study conducted in Germany and Iran are presented in Table 1. According to the studies conducted, it has been reported that the plant samples used have neuroprotective properties for autism [32,34].

2.6. *Camellia sinensis*

Various types of tea, such as black tea, white tea, green tea, yellow tea, and fermented tea, are derived from *Camellia sinensis* (L.) Kuntze (*Theaceae*). The distribution area and origin of the *C. sinensis* plant are commonly recognized as South and Southeast Asia. However, it is also cultivated in tropical and subtropical regions. The leaves are typically hairy, and the flowers are clustered singularly or in groups of three at the stem axil. It has been reported that tea is used for conditions such as coronary artery disease, bad breath, asthma, and angina pectoris, in addition to its consumption as a beverage [81,82]. It has been reported that *C. sinensis* exhibits various biological activities such as antimicrobial, antioxidant, antihemolytic, cytotoxic, antiretroviral, anticancer, antitumor, and anti-inflammatory effects [83,84].

Table 1 displays the varying effects of *C. sinensis* on autism. Within this context, a study conducted in India investigated the effects of tea obtained from the leaves of the *C. sinensis* plant on children with autism. According to the research findings, it has been reported that *C. sinensis* tea suppresses the oxidative stress condition that is present in autism and has a neurological impact [35,39]. A study conducted in Indonesia reported that the compound L-theanine derived from the *C. sinensis* plant serves as an inhibitor that blocks the binding of glutamic acid (Fig. 1) to glutamate receptors on postsynaptic membranes, thereby exhibiting neuroprotective properties. [36]. A study conducted in Venezuela reported that the consumption of 300 mg/kg tea extract of *C. sinensis* led to regeneration in the Purkinje layer and cells of mice [43].

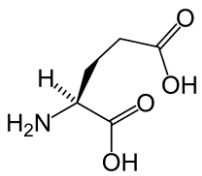

Fig. 1. Chemical formula of glutamic acid.

2.7. *Piper nigrum*

Piper nigrum L., a perennial plant belonging to the Piperaceae family, is commonly known as black pepper. The general distribution area is India. However, in recent times, it has been cultivated in all warm climates. It has been reported that, apart from its use as a condiment and spice, it is also used for ear or nose-throat pains, digestive issues, and respiratory ailments [85,86]. It has been reported that *P. nigrum* exhibits various biological activities such as antimicrobial, analgesic, anti-inflammatory, antioxidant, antimutagenic, antilarvicidal, antidepressant, and hepatoprotective effects [87,88].

The effects of *P. nigrum* on autism are presented in Table 1. A study conducted in India examined the effects of the aerial parts of *P. nigrum* on autism. According to the study findings, it has been reported that the piperine (Fig. 2) alkaloid present in *P. nigrum* possesses antioxidant, neuroprotective, and cognitive-enhancing properties [35, 39].

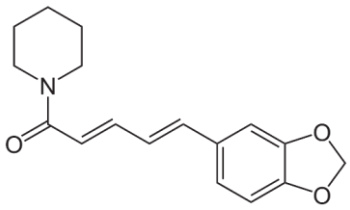

Fig. 2. Chemical formula of piperine

2.8. *Curcuma longa*

Curcuma longa L. is also known as turmeric, curcumin, saffron root, yellow root, Indian saffron, and turmeric root. The distribution area encompasses Bangladesh, India, China, and Pakistan. It has been reported that it is used for purposes beyond its use as a food and dye, such as for muscle pain, osteoarthritis, and allergic conditions [89]. It has been reported that *C. longa* exhibits various biological activities such as antioxidant, antiproliferative, antimicrobial, anti-inflammatory, anticancer, cytotoxic, anticholinesterase, antidiabetic, and antidepressant effects [90,91].

The effects of *C. longa* on autism are presented in Table 1. Within this context, studies conducted in India and Australia have examined the effect of *C. longa* on autism. According to the study findings, it has been reported that curcuminoid compounds and other compounds such as luteolin have an impact on conditions such as neurodegeneration, cell signalling, and neuroprotection [35, 38-40]. In another study conducted in India, it was reported that *C. longa* administered to male Sprague-Dawley rats exhibiting autistic phenotypes at a dose of up to 200 mg/kg reduced oxidative stress, mitochondrial dysfunction, tumour necrosis factor (TNF) release, and matrix degradation metalloproteinases, indicating a potential neuro-psycho-pharmacotherapeutic effect [37].

2.9. *Bacopa monnieri*

Bacopa monnieri (L.) Wettst. is also known as thyme-leafed gratiola, herb of grace, water hyssop, and Indian pennywort. The plant in question is a perennial herbaceous species commonly found in marshy areas. The distribution range of the species encompasses South and East India, Australia, Europe, Africa, Asia, and North and South America [92,93]. It has been reported that *B. monnieri* possesses various biological activities such as antioxidant, antimicrobial, anticancer, antidepressant, cytotoxic, antitumor, analgesic, anti-inflammatory, and anti-diabetic properties [94,95].

The effects of *B. monnieri* on autism are presented in Table 1. Within this context, a study conducted in India examined the effect of *B. monnieri* on autism. According to research findings, it has been reported that bacosides found in *B. monnieri* plant have a positive effect on communication and cognition [35]. In another study conducted in India, the IC50 value of *B. monnieri* on SH-SY5Y human neuroblastoma cell lines was reported to be 93.61 µg. In addition, in the study, it was predicted that the cause of this effect was due to compounds such as alkaloids, glycosides, flavonoids, phenols, saponins, tannins, terpenoids and quinones in the plant [41]. In another study, the effect of valproic acid derived from *B. monnieri* on autism was investigated. According to the study findings, it has been reported that plant usage significantly affects the altered histoarchitecture of the cerebellum by increasing normal behaviour, oxidative stress, and serotonin levels when compared to the normal control group [42].

2.10. *Glycine max*

The plant commonly referred to as *Glycine max* (L.) Merr. is known by the names soybean, soy bean, or soya bean. It is a legume species specific to East Asia. This product has a high nutritional value [96,97]. It has been reported that *G. max* exhibits various biological activities such as antioxidant, antimicrobial, anticancer, anti-inflammatory, and antiherbicidal effects [98,99]. The effects of *G. max* on autism are presented in Table 1. Within this scope, the status of the *G. max* plant on autism has been investigated in India and the United States of America. The use of *G. max* has been suggested as a means to prevent the variability and decrease in dietary intake observed in individuals with autism as a result of the study conducted. It has been reported that this is due to the richness of B6 and B12 vitamins, magnesium, and selenium [35,48]. Another study conducted in the USA reported that genistein and daidzein (Fig. 3) obtained from the *G. max* plant were effective in terms of anti-thyroidism in individuals with autism [47].

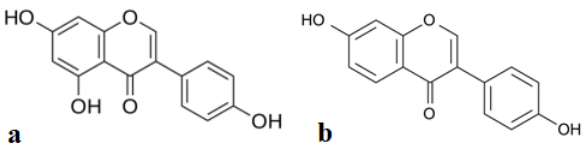

Fig. 3. Chemical formulas of genistein (a) and daidzein (b)

2.11. *Ginkgo biloba*

Ginkgo biloba L., also known as ginkgo or gingko, is a botanical species. Under normal circumstances, *G. biloba* can reach heights of up to 20-35 m. One of the most significant distribution areas is China. The *G. biloba* plant is used to treat schizophrenia, stress, memory loss, Alzheimer's disease, macular degeneration, and cardiovascular ailments [100]. It has been reported that *G. biloba* exhibits various biological activities such as allelopathic, antioxidant, anti-neuroinflammatory, anti-inflammatory, antimicrobial, cytotoxic, antilarvicidal, and anticancer, as well as antidepressant properties [101-103].

The effects of *G. biloba* on autism are presented in Table 1. In this context, a study was conducted in Germany, Iran, and India to investigate the effect of *G. biloba* plant on autism. According to the study findings, compounds such as terpenes, flavonoids, alkyl phenols, luteolin, carboxylic acids, and polyprenols derived from *G. biloba* have been reported to be effective against neurodevelopmental disorders and neuroprotective conditions [32,34,39]. Another study conducted in Egypt reported the impact of flavonoid and phenolic compounds derived from *G. biloba* on social behaviour deficits and neurological aspects [44]. In another study conducted in Italy, it was reported that the administration of 100 mg/kg *G. biloba* twice a day effectively resolved behavioural problems [46].

2.12. *Cannabis* species

The various types of cannabis are also known as hemp. Initially, China and India were the primary regions of general distribution. However, due to factors such as adaptability to the environment and compatibility with soil, it exhibits a wide range of distribution. Due to its fibre properties, it has the potential to be used in various fields. It has been reported that it is used in conditions such as respiratory disorders, digestive system disorders, muscle disorders, poisoning situations, and postpartum difficulties [104,105]. It has been reported that *Cannabis* species exhibit various biological activities such as insecticidal, antioxidant, termiticidal, antimicrobial, cytotoxic, anticancer, antiproliferative, anticholinesterase, and anti-inflammatory properties [106-108].

The effects of cannabis strains on autism are presented in Table 1. Within this context, research has been conducted in Italy, Israel, and the United States on the effects of *Cannabis sativa* L. on autism. According to the findings of these studies, it has been reported that the cannabidiol (Fig. 4a) derived from the plant, along with tetrahydrocannabinol (Fig. 4b), cannabigerol (Fig. 4c) and some other compounds, have neurological, sleep modifying, communication, behavioural, cognitive, and gastrointestinal effects [45,49,51-54,57]. A study conducted in Israel on 60 children reported that compounds such as cannabidiol derived from *Cannabis* sp. reduced sleep disorders, irritability, and loss of appetite by 61% [50].

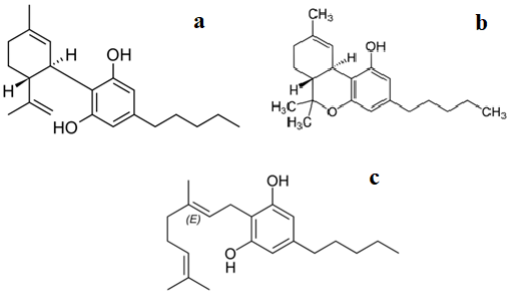

Fig. 4. Chemical formulas of cannabidiol (a), tetrahydrocannabinol (b) and cannabigerol (c)

2.13. *Astragalus membranaceus*

Astragalus membranaceus (Fisch.) Bunge (current name: *Astragalus propinquus* Schischkin), a perennial plant belonging to the *Fabaceae* family, is also known as Mongolian milkvetch. The general distribution area encompasses China, Mongolia, Kazakhstan, Serbia, and Russia [109]. It has been reported that *A. membranaceus* exhibits various biological activities such as anti-ageing, anti-tumor, anticancer, antioxidant, anti-inflammatory, and antimicrobial effects [110,111].

The effects of *A. membranaceus* on autism are presented in Table 1. In this context, studies conducted in Germany, Iran, Turkey, and China have examined the effects of *A. membranaceus* on autism. According to the findings of the study, it has been reported that *A. membranaceus* has a neuroprotective effect [32,34,55,58].

2.14. *Centella asiatica*

Centella asiatica (L.) Urb., also known as Indian pennywort or Asiatic pennywort, is an herbaceous plant belonging to the *Apiaceae* family. Its distribution is observed on islands located in Asia, Australia, Africa, and the Pacific Ocean. *C. asiatica* is commonly used in food products and beverages. It has been reported that it is used in health issues such as dermatitis and skin irritation [112]. It has been reported that *C. asiatica* exhibits various biological activities such as antioxidant, cytotoxic, antimicrobial, anti-allergic, anti-pruritic, anti-inflammatory, antiproliferative, and anticancer effects [113,114].

The effects of *C. asiatica* on autism are presented in Table 1. A study conducted in Germany and Iran reported the neuroprotective effect of *C. asiatica* on the condition of autism [32-34].

2.15. *Salvia* species

The most common species in the *Salvia* genus (*Lamiaceae*) is *Salvia officinalis* L. (commonly known as sage). The general distribution area encompasses the Mediterranean, eastern and southwestern Asia, Mexico, and South America. In addition to its usage in food, beverage, spice, and dye applications, it has also been employed in various contexts such as dental hygiene, ointments, expectorants, cosmetics, food preservation, inflammation, and gum disease [115,116]. It has been reported that *Salvia* species possess various biological activities such as antioxidant, antimicrobial, cytotoxic,

anti-inflammatory, anticholinesterase, antiviral, antiprotozoal, insecticidal, antianxiety, antidiabetic, and anticancer properties [115,116].

The effects of *Salvia* species on autism are presented in Table 1. In a study conducted in Burkina Faso, the anxiolytic and antidepressant effects of *Salvia* sp. were investigated in the context of autism. The study employed the Social Interaction Test (SIT), Elevated Plus Maze (EPM), and Forced Swim (FS) test methods to evaluate the effects of plant-derived essential oils on mice. According to the research findings, it has been reported that valproic acid has an anxiolytic effect by reducing anxiety levels and an antidepressant effect in VPA 500 rats with severe depression [56]. According to a study conducted in Egypt, it has been reported that flavonoid and phenolic compounds obtained from *S. officinalis* have an impact on social behaviour deficits and neurological aspects. This is documented in reference [44].

2.16. *Lepidium sativum*

Lepidium sativum L., commonly known as Garden Cress or Chandrasoor, belongs to the family Brassicaceae. The general distribution area is Asia. However, it is also cultivated in many other places. It has been reported that it is used in conditions such as asthma, syphilis, abortion, bleeding, cough, and as an expectorant [117]. It has been reported that *L. sativum* exhibits various biological activities such as antioxidant, antimicrobial, antigerminative, anti-diabetic, anti-inflammatory, phytotoxicity, allelopathic, hepatoprotective, and anticancer properties [118,119].

The effects of *L. sativum* on autism are presented in Table 1. In this context, a study conducted in Saudi Arabia investigated the effect of *L. sativum* seed on autism. According to the study findings, the plant utilised in the research can serve as a supplementary food source for individuals with autism due to its non-starch carbohydrates, omega-3 polyunsaturated fatty acids and their precursors, flavonoids, and vitamins. [60].

2.17. *Asparagus racemosus*

Asparagus racemosus Willd. is also known as satavar, shatavari, shatamull, and shatawari. The general distribution areas include Africa, India, Asia, and Australia. In addition to its nutritional value and its ability to increase milk production in animals, it has been reported that this substance has various applications such as regulating sexual dysfunction, regulating menstrual cycles, treating endometriosis, gonorrhoea, uterine prolapse, and alleviating symptoms of the common cold [120]. It has been reported that *A. racemosus* exhibits various biological activities such as antimicrobial, antioxidant, antiurolithiatic, anthelmintic, DNA damage protective, antiapoptotic, cytotoxicity, analgesic, antidiarrhoeal, and anticancer properties [121,122].

The effects of *A. racemosus* on autism are presented in Table 1. In the context of this study, an investigation was conducted in India to examine the effects of an extract derived from the roots of the *A. racemosus* plant on autism in mice. According to the study findings, it has been reported that the root extract administered at 100 and 200 mg/kg to pregnant Wistar female rats significantly reduced the oxidative stress caused by valproic acid [61].

2.18. *Passiflora incarnata*

The plant species *Passiflora incarnata* L. (current name: *Passiflora edulis* Sims), belonging to the Passifloraceae family, is commonly referred to as passionflower. The general areas of distribution include regions such as the United States and India, as well as Mexico, the Netherlands, Italy, and Argentina. Furthermore, it can be cultivated even in extremely cold climates. The areas of application include conditions such as nicotine addiction, alcohol addiction, convulsions and sexual dysfunctions [123]. It has been reported that *P. incarnata* exhibits various biological activities such as anti-anxiety, anticonvulsant cytotoxic, antidiabetic, antioxidant, antimicrobial, antihypertensive, antitumor, aphrodisiac and anti-inflammatory properties [124,125].

The effects of *P. incarnata* on autism are presented in Table 1. Within this context, a study conducted in Iran investigated the effect of the hydroalcoholic extract of *P. incarnata* on the condition of autism. In the study, it was reported that administering *P. incarnata* extract at doses of 30, 100, and 300 mg/kg to male Wistar rats until the 35th day after birth resulted in a significant improvement in behavioral disorders and a significant reduction in oxidative stress. [59].

2.19. *Moringa oleifera*

Moringa oleifera Lam., also known as the drumstick tree and horseradish tree, belongs to the Moringaceae family. Typically, the distribution areas are located in tropical and subtropical regions. Apart from its uses in the food, beverage, and cosmetic industries, it has also been employed in various medical conditions such as headache, cough, sensory impairments, digestive disorders, ocular ailments, joint afflictions, cholera, anaemia, and blackheads [126]. It has been reported that *M. oleifera* possesses various biological activities such as antioxidant, antimicrobial, antitumor, anti-inflammatory, anticholinesterase, antivenin, anticancer, antidiabetic, cytotoxic, and antitoxic properties [127,128].

The effects of *M. oleifera* on autism are presented in Table 1. Within this context, an investigation conducted in Egypt evaluated the effect of oil extracted from *M. oleifera* seeds on autism. According to the study findings, *M. oleifera* has been reported to have a positive effect on *Candida* species including *C. albicans, C. dulblinesis, C. glabarata, C. kefyr, C. krusei*, and *C. lusitania* in faecal samples of autistic children and is promising for improving gastrointestinal problems [62].

3. Conclusions

Plants are the source of modern medicine and the most important elements of traditional medicine. Plants can be used to increase the well-being of patients with autism, which is quite common today and consists of many stages with complex treatment. Our research has compiled the plants used to support the treatment in autism cases in the literature. As a result of the research, it was seen that plants support the healing process of autism patients, especially with their neurotransmitter function, oxidative stress suppressor, and gastrointestinal system regulator. However, the paucity of human studies compared to in vivo/in vitro studies has indicated the need to concentrate

on autism treatment. For this reason, in order to reach more detailed and highly reliable scientific data, well-designed clinical studies are needed to determine the real efficacy and safety of plants that have been supportive in the fight against diseases for humans since ancient times.

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References

1. Krupodorova, T.; Sevindik, M. Antioxidant potential and some mineral contents of wild edible mushroom *Ramaria stricta*. *AgroLife Sci. J.,* **2020**, *9(1),* 186-191.
2. Sevindik, M. Antioxidant and antimicrobial capacity of *Lactifluus rugatus* and its antiproliferative activity on A549 cells. *Indian J. Tradit. Know*, **2020**, *19(2),* 423-427. https://doi.org/10.56042/ijtk.v19i2.35356
3. Selamoglu, Z.; Sevindik, M.; Bal, C.; Ozaltun, B.; Sen, İ.; Pasdaran, A. Antioxidant, antimicrobial and DNA protection activities of phenolic content of *Tricholoma virgatum* (Fr.) P. Kumm. *Biointerface Res. Appl. Chem*, **2020**, *10(3*), 5500-5506. https://doi.org/10.33263/BRIAC103.500506
4. Eraslan, E. C.; Altuntas, D.; Baba, H.; Bal, C.; Akgül, H.; Akata, I.; Sevindik, M. Some biological activities and element contents of ethanol extract of wild edible mushroom *Morchella esculenta*. *Sigma J. Engin. Nat. Sci.*, **2021**, *39(1),* 24-28.
5. Sevindik, M. Anticancer, antimicrobial, antioxidant and DNA protective potential of mushroom *Leucopaxillus gentianeus* (Quél.) Kotl. *Indian J. Exp. Biol.,* **2021**, *59(05),* 310-315. https://doi.org/ 10.56042/ijeb.v59i05.50501
6. Bal, C.; Sevindik, M.; Akgul, H.; Selamoglu, Z. Oxidative stress index and antioxidant capacity of *Lepista nuda* collected from Gaziantep/Turkey. *Sigma J. Engin. Nat. Sci.*, **2019**, *37(1),* 1-5.
7. Sevindik, M.; Akgul, H.; Pehlivan, M.; Selamoglu, Z. Determination of therapeutic potential of *Mentha longifolia* ssp. *longifolia*. Fresenius Environ. Bull., 2017, 26(7), 4757-4763.
8. Mohammed, F. S.; Günal, S.; Şabik, A. E.; Akgül, H.; Sevindik, M. Antioxidant and Antimicrobial activity of *Scorzonera papposa* collected from Iraq and Turkey. *KSU J. Agric. Nat.,* **2020**, *23(5),* 1114-1118. https://doi.org/ 10.18016/ksutarimdoga.vi.699457
9. Korkmaz, N.; Dayangaç, A.; Sevindik, M. Antioxidant, antimicrobial and antiproliferative activities of *Galium aparine*. *J. Fac. Pharm. Ankara,* **2021**, *45(3),* 554-564. https://doi.org/10.33483/jfpau.977776
10. Żero, P.; Niemyjska, M.; Rasztawicka, M.; Maciejewska, D. Choroba Nowotworowa Pıersı I Nowe Zwıązkı O Aktywnoścı Przecıwnowotworowej. *Prospects Pharm. Sci.,* **2005**, *3(2),* 10-18. https://doi.org/10.56782/pps.53
11. Kawka, M.; Pilarek, M.; Sykłowska-Baranek, K.; Pietrosiuk, A. Ekstrakcja In Sıtu Roślınnych Metabolıtów Wtórnych. *Prospects Pharm. Sci.,* **2017**, *15(7),* 60-67. https://doi.org/10.56782/pps.78
12. Mohammed, F. S.; Akgul, H.; Sevindik, M.; Khaled, B. M. T. Phenolic content and biological activities of *Rhus coriaria* var. *zebaria*. *Fresenius Environ. Bull.,* **2018,** *27(8),* 5694-5702.
13. Mohammed, F. S.; Karakaş, M.; Akgül, H.; Sevindik, M. Medicinal properties of *Allium calocephalum* collected from Gara Mountain (Iraq). *Fresenius Environ. Bull.,* **2019,** *28(10),* 7419-7426.
14. Mohammed, F. S.; Pehlivan, M.; Sevindik, E.; Akgul, H.; Sevindik, M.; Bozgeyik, I.; Yumrutas, O. Pharmacological properties of edible *Asparagus acutifolius* and *Asparagus officinalis* collected from North Iraq and Turkey (Hatay). *Acta Aliment.,* **2021,** *50(1),* 136-143. https://doi.org/10.1556/ 066.2020.00204
15. Unal, O.; Eraslan, E. C.; Uysal, I.; Mohammed, F. S.; Sevindik, M.; Akgul, H. Biological activities and phenolic contents of Rumex scutatus collected from Turkey. *Fresenius Environ. Bull.,* **2022**, *31(7),* 7341-7346.
16. Mohammed, F. S.; Uysal, I.; Sevindik, M. Functional food Momordica charantia: biological activities. *Prospects Pharm. Sci.,* **2023**, *21(3),* 22-29. https://doi.org/10.56782/pps.138
17. Mohammed, F. S.; Kına, E.; Sevindik, M.; Doğan, M.; Pehlivan, M. Antioxidant and antimicrobial activities of ethanol extract of *Helianthemum salicifolium* (Cistaceae). *Indian J. Nat. Prod. Resour.,* **2021,** *12(3),* 459-462. https://doi.org/ 10.56042/ ijnpr.v12i3.46635
18. Mohammed, F. S.; Günal, S.; Pehlivan, M.; Doğan, M.; Sevindik, M.; Akgül, H. Phenolic content, antioxidant and antimicrobial potential of endemic *Ferulago platycarpa*. *Gazi Univ. J. Sci.,* **2020,** *33(4),* 670-677. https://doi.org/10.35378/gujs.707555
19. Mohammed, F. S.; Uysal, I.; Sevindik, M. A review on antiviral plants effective against different virus types. *Prospects Pharm. Sci.,* **2023,** *21(2),* 1-21. https://doi.org/10.56782/pps.128
20. Johnson, C. P.; Myers, S. M. Identification and evaluation of children with autism spectrum disorders. *Pediatrics*, **2007,** *120(5),* 1183-1215. https://doi.org/10.1542/peds.2007-2361
21. Frith, U.; Mira, M. Autism and Asperger syndrome. *Focus on Autistic Behavior,* **1992**, *7(3),* 13-15. https://doi.org/10.1177/108835769200700302
22. Maenner, M. J.; Shaw, K. A.; Baio, J.; Washington, A.; Patrick, M.; DiRienzo, M.; Christensen, D.L.; Wiggins, L.D.; Pettygrove, S.; Andrews, J.G.; Lopez, M.,; Hudson, A.; Baroud, T.; Schwenk, Y.; White, T.; Rosenberg, C.R.; Lee, L.C.; Harrington, R.A.;

Huston, M.; Hewitt, A.; Esler, A.; Hall-Lande, J.; Poynter, J.N.; Hallas-Muchow, L.; Constantino, J.N.; Fitzgerald, R.T.; Zahorodny, W.; Shenouda, J.; Daniels, J.L.; Warren, Z.; Vehorn, A.; Salinas, A.; Durkin, M.S.; Dietz, M.P. Prevalence of autism spectrum disorder among children aged 8 years—autism and developmental disabilities monitoring network, 11 sites, United States, 2016. *MMWR Surveill Summ*, **2020**, *69(4),* 1-12. https://doi.org/10.15585/mmwr.ss6904a1

23. Won, H.; Mah, W.; Kim, E. Autism spectrum disorder causes, mechanisms, and treatments: focus on neuronal synapses. *Front. Mol. Neurosci.,* **2013**, *6,* 19. https://doi.org/10.3389/fnmol.2013.00019

24. Muhle, R.; Trentacoste, S. V.; Rapin, I. The genetics of autism. *Pediatrics,* **2004,** *113(5),* e472-e486. https://doi.org/10.1542/peds.113.5.e472

25. Baron-Cohen, S. Autism: the empathizing–systemizing (E-S) theory. *Ann. N. Y. Acad. Sci.*, **2009**, *1156(1),* 68-80.

26. Kemper, T. L.; Bauman, M. L. The contribution of neuropathologic studies to the understanding of autism. *Neurol. Clin.*, **1993**, *11(1),* 175-187. https://doi.org/10.1016/S0733-8619(18)30176-2

27. Rogers, S. J.; Vismara, L. A. Evidence-based comprehensive treatments for early autism. *J. Clin. Child Adolesc.*, **2008**, *37(1),* 8-38. https://doi.org/10.1080/15374410701817808

28. Brentani, H.; Paula, C. S. D.; Bordini, D.; Rolim, D.; Sato, F.; Portolese, J.; McCracken, J. T. Autism spectrum disorders: an overview on diagnosis and treatment. *Rev. Bras. de Psiquiatr.*, **2013**, *35,* S62-S72. https://doi.org/10.1590/1516-4446-2013-S104

29. Van Bourgondien, M. E.; Reichle, N. C.; Schopler, E. Effects of a model treatment approach on adults with autism. *J. Autism Dev. Disord.*, **2003**, *33,* 131-140.

30. Ernst, E.; Pittler, M. H. Efficacy of ginger for nausea and vomiting: a systematic review of randomized clinical trials. *Br. J. Anaesth.*, **2000**, *84(3),* 367-371. https://doi.org/10.1093/oxfordjournals.bja.a013442

31. Gupta, Y. K.; Sharma, M. Reversal of pyrogallol-induced delay in gastric emptying in rats by ginger (*Zingiber officinale*). *Methods Find. Exp. Clin. Pharmacol.*, **2001**, *23(9),* 501-503. https://doi.org/10.1358/mf.2001.23.9.662137

32. Parashar, A.; Udayabanu, M. Gut microbiota regulates key modulators of social behavior. *Eur. Neuropsychopharmacol.*, **2016**, *26(1),* 78-91. https://doi.org/10.1016/j.euroneuro.2015.11.002

33. Rezapour, S.; Bahmani, M.; Afsordeh, O.; Rafieian, R.; Sheikhian, A. Herbal medicines: a new hope for autism therapy. *J. Herbmed Pharma.*, **2016,** *5(3),* 89-91.

34. Kardani, A.; Soltani, A.; Sewell, R. D.; Shahrani, M.; Rafieian-Kopaei, M. Neurotransmitter, antioxidant and anti-neuroinflammatory mechanistic potentials of herbal medicines in ameliorating autism spectrum disorder. *Curr. Pharm. Des.*, **2019**, *25(41),* 4421-4429. https://doi.org/10.2174/1381612825666191112143940

35. Chilambath, M.; Sundararaman, G. Herbal Remedies for Autism. In Role of Nutrients in Neurological Disorders (pp. 333-347). **2022**, Singapore: Springer Singapore.

36. Amin, M.; Khikmawati, N. H.; Suryadi, Amin, I. F.; Yayoi, K..; Wibowo, A. H.; Rachman, I. Chemical interaction analysis of L-Theanine compounds from Camellia sinensis L. with kainate glutamate receptors and their toxicity effect as anti-autism candidates based on in silico. In AIP Conference Proceedings (Vol. 2237, No. 1, p. 020072). **2020**, AIP Publishing LLC.

37. Bhandari, R.; Kuhad, A. Neuropsychopharmacotherapeutic efficacy of curcumin in experimental paradigm of autism spectrum disorders. *Life Sci.*, **2015**, *141*, 156-169. https://doi.org/10.1016/j.lfs.2015.09.012

38. Bhat, A.; Mahalakshmi, A. M.; Ray, B.; Tuladhar, S.; Hediyal, T. A.; Manthiannem, E.; Sakharkar, M. K.. Benefits of curcumin in brain disorders. *BioFactors*, **2019**, *45(5),* 666-689. https://doi.org/10.1002/biof.1533

39. Deb, S.; Phukan, B. C.; Dutta, A.; Paul, R.; Bhattacharya, P.; Manivasagam, T.; Borah, A. Natural products and their therapeutic effect on autism spectrum disorder. Personalized Food Intervention and Therapy for Autism Spectrum Disorder Management, **2020**, 601-614.

40. Lopresti, A. L. Curcumin for neuropsychiatric disorders: a review of in vitro, animal and human studies. *J. Psychopharmacol.*, **2017**, *31(3),* 287-302. https://doi.org/10.1177/0269881116686883

41. Muralidharan, P.; Anamika, P.K. Preclinical Investigation On The Protective Effect Of Bacopa Monnieri On Human Neuroblastoma Cell Line SH-SY5Y On Its Progressive Development And Finding On Autism Spectrum Disorder. *J. Pharm. Negat.*, **2022**, 2262-2269. https://doi.org/10.47750/pnr.2022.13.S09.270

42. Sandhya, T.; Sowjanya, J.; Veeresh, B. Bacopa monniera (L.) Wettst ameliorates behavioral alterations and oxidative markers in sodium valproate induced autism in rats. *Neurochem. Res.*, **2012**, *37,* 1121-1131.

43. Urdaneta, K. E.; Castillo, M. A.; Montiel, N.; Semprún-Hernández, N.; Antonucci, N.; Siniscalco, D. Autism spectrum disorders: potential neuro-psychopharmacotherapeutic plant-based drugs. *Assay Drug Dev. Technol.,* **2018**, *16(8),* 433-444. https://doi.org/10.1089/adt.2018.848

44. Ahmed, A. A.; Eltahan, N. R.; Elsherif, S. A.; Elsaadany, M. Therapeutic Effect of Selected Plants on Autistic Rats. *J. Home Econ., 2018*, 28.

45. Hadland, S. E.; Knight, J. R.; Harris, S. K. Medical marijuana: Review of the science and implications for developmental behavioral pediatric practice. *J. Dev. Behav. Pediatr.*, **2015**, *36(2),* 115-123. https://doi.org/ 10.1097/DBP.0000000000000129

46. Niederhofer, H. First preliminary results of an observation of *Ginkgo Biloba* treating patients with autistic disorder. *Phyto. Res.*, **2009**, *23(11),* 1645-1646. https://doi.org/10.1002/ptr.2778

47. Román, G. C. Autism: transient in utero hypothyroxinemia related to maternal flavonoid ingestion during pregnancy and to other environmental antithyroid agents. *J. Neurol. Sci.*, **2007**, *262(1-2),* 15-26. https://doi.org/10.1016/j.jns.2007.06.023

48. Woolf, A. D. Herbal remedies and children: do they work? Are they harmful?. *Pediatrics*, **2003**, *112(1-2),* 240-246.

49. Agarwal, R., Burke, S. L., Maddux, M. (2019). Current state of evidence of cannabis utilization for treatment of autism spectrum disorders. *BMC psychiatry*, **2003**, *19(1),* 1-10.

50. Aran, A.; Cassuto, H.; Lubotzky, A.; Wattad, N.; Hazan, E. Brief report: cannabidiol-rich cannabis in children with autism spectrum disorder and severe behavioral problems—a retrospective feasibility study. *J. Autism Dev. Disord.*, **2019**, *49(3),* 1284-1288.

51. Mostafavi, M.; Gaitanis, J.. Autism spectrum disorder and medical cannabis: review and clinical experience. In Seminars in pediatric neurology (Vol. 35, p. 100833). **2020**, WB Saunders.

52. Perucca, E.. Cannabinoids in the treatment of epilepsy: hard evidence at last?. *J. Epilepsy Res.*, **2017**, *7(2),* 61. https://doi.org/ 10.14581/jer.17012

53. Solimini, R.; Rotolo, M. C.; Pichini, S.; Pacifici, R. Neurological disorders in medical use of cannabis: an update. *CNS Neurol. Disord. Drug. Targets*, **2017**, *16(5),* 527-533. https://doi.org/10.2174/1871527316666170413105421

54. Babayeva, M.; Assefa, H.; Basu, P.; Loewy, Z. Autism and associated disorders: cannabis as a potential therapy. *Frontiers in Bioscience-Elite*, **2022**, *14(1),* 1. https://doi.org/ 10.31083/j.fbe1401001

55. Bedir, E.; Pugh, N.; Calis, I.; Pasco, D. S.; Khan, I. A. Immunostimulatory effects of cycloartane-type triterpene glycosides from Astragalus species. *Biol. Pharma. Bull.*, **2000**, *23(7),* 834-837. https://doi.org/10.1248/bpb.23.834

56. Guenné, S.; Ouedraogo, G. G.; Lefter, R.; Timofte, D.; Foyet, H. S.; Hilou, A.; Kiendrebéogo, M. Anxiolytic and anti-depressant effect of Salvia spp. essential oil on rat model of Autism Spectrum Disorder. *Bull. Integ. Psych.*, **2020**, *84(1),* 19-28.

57. Schnapp, A.; Harel, M.; Cayam-Rand, D.; Cassuto, H.; Polyansky, L.; Aran, A. A Placebo-Controlled Trial of Cannabinoid Treatment for Disruptive Behavior in Children and Adolescents with Autism Spectrum Disorder: Effects on Sleep Parameters as Measured by the CSHQ. *Biomedicines*, **2022**, *10(7),* 1685. https://doi.org/10.3390/biomedicines10071685

58. Zheng, Z.; Liu, D.; Song, C.; Cheng, C.; Hu, Z. Studies on chemical constituents and immunological function activity of hairy root of *Astragalus membranaceus*. *Chinese j. biotech.*, **1998**, *14(2),* 93-97.

59. Amini, F.; Amini-Khoei, H.; Haratizadeh, S.; Setayesh, M.; Basiri, M.; Raeiszadeh, M.; Nozari, M. Hydroalcoholic extract of Passiflora incarnata improves the autistic-like behavior and neuronal damage in a valproic acid-induced rat model of autism. *J. Tradit. Complement. Med.*, **2023**, https://doi.org/10.1016/j.jtcme.2023.02.005.

60. El-Ansary, A.; Ibrahim, E. M.; Shafi Bhat, R.. *Lepidium sativum* seeds as a suggested complex nutritional supplement to treat biomarkers related deficits in autism. *Nov. Tech. Nutr. Food Sci.*, **2019**, *3(3),* 258-62.

61. Joon, P.; Dhingra, D.; Parle, M. Biochemical evidence for anti-autistic potential of *Asparagus racemosus*. *Int. J. Plant Sci.*, **2020**, *15(1),* 42-51.

62. Nessma, E.; Metwally, M. A.; Samah, H. Assessment of Oil and Seed Extracts of *Moringa oleifera* for Promising Anticandidal Activity in Autistic Children. *Egyptian J. Bot.*, **2022**, 62(3), 825-835. https://doi.org/ 10.21608/ejbo.2022.61779.1624

63. Dhanik, J.; Arya, N.; Nand, V. A review on *Zingiber officinale*. *J. pharmacogn. phytochem.*, **2017**, 6(3), 174-184.

64. Ujang, Z.; Nordin, N. I.; Subramaniam, T. Ginger species and their traditional uses in modern applications. *J. Ind. Technol.* **2015**, *23(1),* 59-70.

65. Kumar Gupta, S.; Sharma, A. Medicinal properties of *Zingiber officinale* Roscoe-A review. *J. Pharm. Biol. Sci,* **2014**, *9,* 124-129.

66. Loying, R.; Gogoi, R.; Sarma, N.; Borah, A.; Munda, S.; Pandey, S. K.; Lal, M. Chemical compositions, in-vitro antioxidant, anti-microbial, anti-inflammatory and cytotoxic activities of essential oil of Acorus calamus L. rhizome from North-East India. *J. Essent. Oil-Bear. Plants,* **2019**, *22(5),* 1299-1312.

67. Rajput, S. B.; Tonge, M. B.; Karuppayil, S. M. An overview on traditional uses and pharmacological profile of *Acorus calamus* Linn.(Sweet flag) and other Acorus species. *Phytomedicine*, **2014**, *21(3),* 268-276. https://doi.org/10.1016/j.phymed.2013.09.020

68. Balakumbahan, R.; Rajamani, K.; Kumanan, K. Acorus calamus: An overview. *J. Med. Plants Res.*, **2010**, *4(25),* 2740-2745.

69. Singh, R.; Sharma, P. K.; Malviya, R. Pharmacological properties and ayurvedic value of Indian buch plant (*Acorus calamus*): a short review. *Adv. Biol. Res.*, **2011**, *5(3),* 145-154.

70. Pachiappan, S.; Matheswaran, S.; Saravanan, P. P.; Muthusamy, G. Medicinal plants for polycystic ovary syndrome: A review of phytomedicine research. *Int. J. Herb. Med.*, **2017**, *5(2),* 78-80.

71. Salari, S.; Amiri, M. S.; Ramezani, M.; Moghadam, A. T.; Elyasi, S.; Sahebkar, A.; Emami, S. A. Ethnobotany, phytochemistry, traditional and modern uses of *Actaea racemosa* L.(Black cohosh): a review. Pharmacological Properties of Plant-Derived Natural Products and Implications for Human Health, **2021**, 403-449.

72. Nuntanakorn, P.; Jiang, B.; Einbond, L. S.; Yang, H.; Kronenberg, F.; Weinstein, I. B.; Kennelly, E. J. Polyphenolic Constituents of Actaea racemosa. *J. Nat. Prod.*, **2006**, *69(3),* 314-318.

73. Kursinszki, L. Factors influencing the pharmaceutically important characteristics of

Lobelia inflata L. *Afr. J. Tradit. Complement. Altern. Med.*, **2009**, 318-318.

74. Folquitto, D. G.; Swiech, J. N.; Pereira, C. B.; Bobek, V. B.; Possagno, G. C. H.; Farago, P. V.; Miguel, O. G. Biological activity, phytochemistry and traditional uses of genus Lobelia (Campanulaceae): A systematic review. *Fitoterapia*, **2019**, *134*, 23-38. https://doi.org/10.1016/j.fitote.2018.12.021

75. Máthé, Á. Indian Tobacco (*Lobelia inflata* L.). Medicinal and Aromatic Plants of North America, **2020**, 159-186.

76. Subarnas, A.; Tadano, T.; Nakahata, N.; Arai, Y.; Kinemuchi, H.; Oshima, Y.; Ohizumi, Y. A possible mechanism of antidepresant activity of beta-amyrin palmitate isolated from lobelia inflata leaves in the forced swimming test. *Life Sci.,* **1993***, 52(3),* 289-296.

77. He, D. Y.; Dai, S. M. Anti-inflammatory and immunomodulatory effects of Paeonia lactiflora Pall., a traditional Chinese herbal medicine. *Frontiers pharmacol.,* **2011**, *2*, 10. https://doi.org/10.3389/fphar.2011.00010

78. Parker, S.; May, B.; Zhang, C.; Zhang, A. L.; Lu, C.; Xue, C. C. A pharmacological review of bioactive constituents of *Paeonia lactiflora* Pallas and *Paeonia veitchii* Lynch. *Phyto. Res.*, **2016**, *30(9),* 1445-1473. https://doi.org/10.1002/ptr.5653

79. Zhao, D. D.; Jiang, L. L.; Li, H. Y.; Yan, P. F.; Zhang, Y. L. Chemical components and pharmacological activities of terpene natural products from the genus Paeonia. *Molecules*, **2016**, *21(10),* 1362. https://doi.org/10.3390/molecules21101362

80. Parker, S.; May, B.; Zhang, C.; Zhang, A. L.; Lu, C.; Xue, C. C. A pharmacological review of bioactive constituents of *Paeonia lactiflora* Pallas and *Paeonia veitchii* Lynch. *Phyto. Res.*, **2016**, *30(9),* 1445-1473. https://doi.org/10.1002/ptr.5653

81. Ferrara, L.; Montesano, D.; Senatore, A. The distribution of minerals and flavonoids in the tea plant (*Camellia sinensis*). *Il farmaco*, **2001**, *56(5-7),* 397-401. https://doi.org/10.1016/S0014-827X(01)01104-1

82. Sharangi, A. B. Medicinal and therapeutic potentialities of tea (*Camellia sinensis* L.)–A review. *Food Res. Int.*, **2009**, *42(5-6),* 529-535. https://doi.org/10.1016/j.foodres.2009.01.007

83. Namita, P.; Mukesh, R.; Vijay, K. J. *Camellia sinensis* (green tea): a review. *Glob. J. Pharmacol.*, **2012**, *6(2),* 52-59.

84. Zhang, L.; Ho, C. T.; Zhou, J.; Santos, J. S.; Armstrong, L.; Granato, D. Chemistry and biological activities of processed *Camellia sinensis t*eas: A comprehensive review. *Compr. Rev. Food Sci. Food Saf.,* **2019**, *18(5),* 1474-1495.

85. Thangaselvabal, T.; Gailce Leo Justin, C.; Leelamathi, M. Black pepper (*Piper nigrum* L.)'the king of spices'–A review. *Agri. Rev.*, **2008**, *29(2),* 89-98.

86. Meghwal, M.; Goswami, T. K. *Piper nigrum* and piperine: an update. *Phyto. Res.*, **2013**, *27(8),* 1121-1130.

87. Damanhouri, Z. A.; Ahmad, A. A review on therapeutic potential of *Piper nigrum* L. Black Pepper): The King of Spices. *Med. Aromat. Plants*, **2014**, *3(3),* 161. http://dx.doi.org/10.4172/2167-0412.1000161

88. Ashokkumar, K.; Murugan, M.; Dhanya, M. K.; Pandian, A.; Warkentin, T. D. Phytochemistry and therapeutic potential of black pepper [*Piper nigrum* (L.)] essential oil and piperine: A review. *Clin. Phytosci.*, **2021**, *7(1),* 1-11.

89. Akram, M.; Shahab-Uddin, A. A.; Usmanghani, K. H. A. N.; Hannan, A. B. D. U. L.; Mohiuddin, E.; Asif, M. *Curcuma longa* and curcumin: a review article. *Rom. J. Biol. Plant. Biol.*, **2010**, *55(2),* 65-70.

90. Krup, V.; Prakash, L. H.; Harini, A. Pharmacological activities of turmeric (*Curcuma longa* Linn): a review. *J. Homeop. Ayurv. Med.*, **2013**, *2(133),* 2167-1206.

91. Labban, L. Medicinal and pharmacological properties of Turmeric (*Curcuma longa*): A review. *Int. J. Pharm. Biomed. Sci.*, **201**4, *5(1),* 17-23.

92. Tripathi, N.; Chouhan, D. S.; Saini, N.; Tiwari, S. Assessment of genetic variations among highly endangered medicinal plant *Bacopa monnieri* (L.) from Central India using RAPD and ISSR analysis. *3 Biotech*, **2012**, *2*, 327-336.

93. Sudhakaran, M. V. Botanical Pharmacognosy of *Bacopa monnieri* (Linn.) Pennell. *Pharmacogn. J.*, **2020**, *12(6),* 1559-1572.

94. Jain, P. K.; Das, D.; Jain, P.; Jain, P. Pharmacognostic and pharmacological aspect of *Bacopa monnieri*: a review. *Int. J. Pharm. Pharm. Sci.*, **2016**, 4(3), 7-11.

95. Vishnupriya, P.; Padma, V. V. A review on the antioxidant and therapeutic potential of *Bacopa monnieri*. *React. Oxygen Spec.*, **2017**, *3*, 111-120.

96. Brar, G. S.; Carter Jr, T. E. Soybean: *Glycine max* (L) Merrill. Genetic improvement of vegetable crops, **1993**, 427-463.

97. Stupar, R. M.; Specht, J. E. Insights from the soybean (*Glycine max* and *Glycine soja*) genome: past, present, and future. *Adv. Agron.*, **2013**, *118*, 177-204. https://doi.org/10.1016/B978-0-12-405942-9.00004-9

98. Ponnusha, B. S.; Subramaniyam, S.; Pasupathi, P. Antioxidant and Antimicrobial properties of *Glycine max*-A review. *Int. J. Cur. Bio. Med. Sci.*, **2011**, *1(2),* 49-62.

99. Fischer, E.; Cachon, R.; Cayot, N. *Pisum sativum* vs *Glycine max*, a comparative review of nutritional, physicochemical, and sensory properties for food uses. *Trends Food Sci. Tech.*, **2020**, *95*, 196-204. https://doi.org/10.1016/j.tifs.2019.11.021

100. Mahadevan, S.; Park, Y. Multifaceted therapeutic benefits of *Ginkgo biloba* L.: chemistry, efficacy, safety, and uses. *Journal of food science*, **2008**, *73(1),* 14-19. https://doi.org/10.1111/j.1750-3841.2007.00597.x

101. Fang, J.; Wang, Z.; Wang, P.; Wang, M. Extraction, structure and bioactivities of the polysaccharides from *Ginkgo biloba*: A review. *Int. J. Biol.*

Macromol., **2020**, *162*, 1897-1905. https://doi.org/10.1016/j.ijbiomac.2020.08.141

102. Yoshikawa, T.; Naito, Y.; Kondo, M. *Ginkgo biloba* leaf extract: review of biological actions and clinical applications. *Antioxid. Redox. Signal.*, **1999**, *1(4),* 469-480. https://doi.org/10.1089/ars.1999.1.4-469
103. Ude, C.; Schubert-Zsilavecz, M.; Wurglics, M. *Ginkgo biloba* extracts: a review of the pharmacokinetics of the active ingredients. *Clin. Pharmacokinet.*, **2013**, *52*, 727-749.
104. Clarke, R. C.; Watson, D. P. Botany of natural Cannabis medicines. Cannabis and cannabinoids: pharmacology, toxicology and therapeutic potential, **2002**, 3-13.
105. Rajput, R.; Kumar, K. A review on *Cannabis sativa*: its compounds and their effects. *Int. J. Pharm. Sci. Rev. Res.*, **2018**, *53(2),* 59-63.
106. Manosroi, A.; Chankhampan, C.; Kietthanakorn, B. O.; Ruksiriwanich, W.; Chaikul, P.; Boonpisuttinant, K.; Manosroi, J. Pharmaceutical and cosmeceutical biological activities of hemp (*Cannabis sativa* L. var. *sativa*) leaf and seed extracts. *Chiang Mai J. Sci*, **2019**, *46*, 180-195.
107. Ashton, C. H. Pharmacology and effects of cannabis: a brief review. *BJPsych*, **2001**, *178(2),* 101-106.
108. Asadi, S.; Moghadam, H.; Naghdi Badi, H.; Naghavi, M. R.; Salami, S. A. R. A review on agronomic, phytochemical and pharmacological aspects of cannabis (*Cannabis sativa* L.). *J. Med. Plants*, **2019**, *18(70),* 1-20.
109. Fu, J.; Wang, Z.; Huang, L.; Zheng, S.; Wang, D.; Chen, S.; Yang, S. Review of the botanical characteristics, phytochemistry, and pharmacology of *Astragalus membranaceus* (Huangqi). *Phytother. Res*, **2014**, *28(9),* 1275-1283. https://doi.org/10.1002/ptr.5188
110. Zhang, J.; Wu, C.; Gao, L.; Du, G., Qin, X. Astragaloside IV derived from *Astragalus membranaceus*: A research review on the pharmacological effects. *Adv. Pharma.*, **2020**, 87, 89-112. https://doi.org/10.1016/bs.apha.2019.08.002
111. Jin, M.; Zhao, K.; Huang, Q.; Shang, P. Structural features and biological activities of the polysaccharides from Astragalus membranaceus. *Int. J. Biol. Macromol.*, **2014**, *64*, 257-266.
112. Gohil, K. J.; Patel, J. A.; Gajjar, A. K.. Pharmacological review on Centella asiatica: a potential herbal cure-all. *Indian J. Pharm. Sci.*, **2010**, 72(5), 546.
113. Pittella, F.; Dutra, R. C.; Junior, D. D.; Lopes, M. T.; Barbosa, N. R. Antioxidant and cytotoxic activities of *Centella asiatica* (L) Urb. *Int. J. Mol. Sci.,* **2009**, *10(9),* 3713-3721.
114. Torbati, F. A.; Ramezani, M.; Dehghan, R.; Amiri, M. S.; Moghadam, A. T.; Shakour, N.; Emami, S. A. Ethnobotany, phytochemistry and pharmacological features of *Centella asiatica*: a comprehensive review. Pharmacological Properties of Plant-Derived Natural Products and Implications for Human Health, **2021**, 451-499.
115. Pehlivan, M.; Sevindik, M. Antioxidant and antimicrobial activities of *Salvia multicaulis*. *Turkish JAF Sci.Tech.*, **2018**, *6(5),* 628-631.
116. Uysal, I.; Koçer, O.; Mohammed, F. S.; Lekesiz, Ö.; Doğan, M.; Şabik, A. E.; Sevindik, E.; Gerçeker, F.Ö.; Sevindik, M. Pharmacological and Nutritional Properties: Genus Salvia. *Adv. Pharmacol. Pharm.*, **2023**, *11(2),* 140-155. https://doi.org/10.13189/app.2023.110206
117. Baregama, C.; Goyal, A. Phytoconstituents, pharmacological activity, and medicinal use of *Lepidium sativum* Linn.: A review. *Asian J. Pharm. Clin. Res.*, **2019**, *12(4),* 45-50.
118. Al-Snafi, A. E. Chemical constituents and pharmacological effects of *lepidium sativum*. *Int. J. Curr. Pharm. Res.*, **2019**, *11(6),* 1-10.
119. Mali, R. G.; Mahajan, S. G.; Mehta, A. A. *Lepidium sativum* (Garden cress): a review of contemporary literature and medicinal properties. *Adv. Tradit. Med.*, **2007**, *7(4),* 331-335. https://doi.org/10.3742/OPEM.2007.7.4.331
120. Alok, S.; Jain, S. K.; Verma, A.; Kumar, M.; Mahor, A.; Sabharwal, M. Plant profile, phytochemistry and pharmacology of *Asparagus racemosus* (Shatavari): A review. *Asian Pac. J. Trop. Dis.*, **2013**, 3(3), 242-251. https://doi.org/10.1016/S2222-1808(13)60049-3
121. Shaha, P.; Bellankimath, A. Pharmacological profile of *Asparagus racemosus*: A review. *Int. J. Curr. Microbiol. App. Sci.*, **2017**, *6(11),* 1215-23.
122. Mishra, J. N.; Verma, N. K. *Asparagus racemosus*: chemical constituents and pharmacological activities-a review. *Eur. J. Biomed. Pharm. Sci.*, **2017**, *4,* 207-213.
123. Patel, S. S.; Saleem, T. M.; Ravi, V.; Shrestha, B.; Verma, N. K.; Gauthaman, K. *Passiflora incarnata* Linn: A phytopharmacological review. *Int. J. Green Pharm.*, **2009**, *3(4),* 277-280.
124. Patel, S.; Verma, N.; Gauthaman, K. *Passiflora incarnata* Linn: A review on morphology, phytochemistry and pharmacological aspects. *Phcog. Rev.*, **2009**, *3(5),* 186.
125. Tiwari, S.; Singh, S.; Tripathi, S.; Kumar, S. A pharmacological review: Passiflora species. *Asian J. Pharm. Res.,* **2015**, *5(4),* 195-202.
126. Mahmood, K. T.; Mugal, T.; Haq, I. U. *Moringa oleifera*: a natural gift-A review. *J. Pharm. Sci. Res.*, **2010**, *2(11),* 775.
127. Bhattacharya, A.; Tiwari, P.; Sahu, P. K.; Kumar, S. A review of the phytochemical and pharmacological characteristics of *Moringa oleifera*. *J. Pharm. Bioallied. Sci.,* **2018**, *10(4),* 181. https://doi.org/10.4103/JPBS.JPBS_126_18
128. Pareek, A.; Pant, M.; Gupta, M. M.; Kashania, P.; Ratan, Y.; Jain, V.; Chuturgoon, A. A. *Moringa oleifera*: An updated comprehensive review of its pharmacological activities, ethnomedicinal, phytopharmaceutical formulation, clinical, phytochemical, and toxicological aspects. *Int. J. Mol. Sci.*, **2023**, *24(3),* 2098. https://doi.org/10.3390/ijms24032098