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NEURODEGENERATIVE DISEASES TREATMENT BY ADVANCED HERBAL DRUG TECHNOLOGY

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Abstract

Worldwide, neurodegenerative diseases including Alzheimer's, Parkinson's, and many others pose a serious health concern as people age. In recent years, efforts have been made to understand the mechanism of neurodegenerative diseases and to develop potential therapies that may assist to delay the effects of ageing and prevent these conditions. Since various factors are involved in the pathogenesis of these diseases, neuroscientists must pinpoint these multiple factors to stop age-related neurodegenerative diseases. Herbal medications have traditionally been used to treat neural problems. Even though the precise mechanisms of action of herbal medications are still unknown, several of them have been demonstrated to have anti-inflammatory and/or antioxidant effects in several peripheral systems. Anti-inflammatory herbal medicine and its contents are now being demonstrated to be an effective neuroprotector against many brain disorders as increasing data suggest that neuroglia-derived chronic inflammatory responses play a pathogenic function in the central nervous system. A valuable source of novel lead compounds against therapeutic targets that have recently been identified by genomes, proteomics, and high-throughput screening is the structural diversity of medicinal herbs.

KEYWORDS: Neurodegenerative diseases, Soxhlet extraction, Neuroprotective, Curcumin, Nasal spray.

1.INTRODUCTION

A group of disorders known as "neurodegenerative diseases" specifically target the neurons (nerve cells) in the brain and/or spinal cord. Neuronal structure and function gradually deteriorate as a result of these disorders, impairing cognitive, motor, and/or sensory capacities.

There are various types of neurodegenerative diseases, (Fig.1) including:

1. **Alzheimer's disease:** Alzheimer's disease is the most prevalent type of dementia and is characterised by an abnormal build-up of proteins in the brain, which causes memory, thought, and behaviour to gradually deteriorate.
2. **Parkinson's disease**: The loss of dopamine-producing cells in a specific region of the brain causes this condition, which inhibits mobility. Parkinson's disease is characterised by tremors, rigidity, and bradykinesia (slowness of movement).
3. **Huntington's disease:** This is a hereditary disease that causes progressive nerve cell degeneration in the brain, resulting in uncontrollable movements, emotional and psychological disorders, and cognitive deterioration.

4. **Amyotrophic lateral sclerosis (ALS):** ALS, often known as Lou Gehrig's disease, is a progressive neurodegenerative disease that damages nerve cells that regulate voluntary muscles, resulting in muscle weakening, paralysis, and, eventually, death.
5. **Multiple sclerosis (MS):** MS is an autoimmune disease that attacks the central nervous system, causing the protective covering of nerve fibres (myelin) to be destroyed, resulting in a variety of symptoms such as fatigue, difficulty walking, numbness or tingling in extremities, and decreased coordination.
6. **Frontotemporal dementia:** This is a collection of rare neurodegenerative conditions that mostly affect the frontal and temporal lobes of the brain, causing personality, behaviour, and language problems. [1,2,3,4]

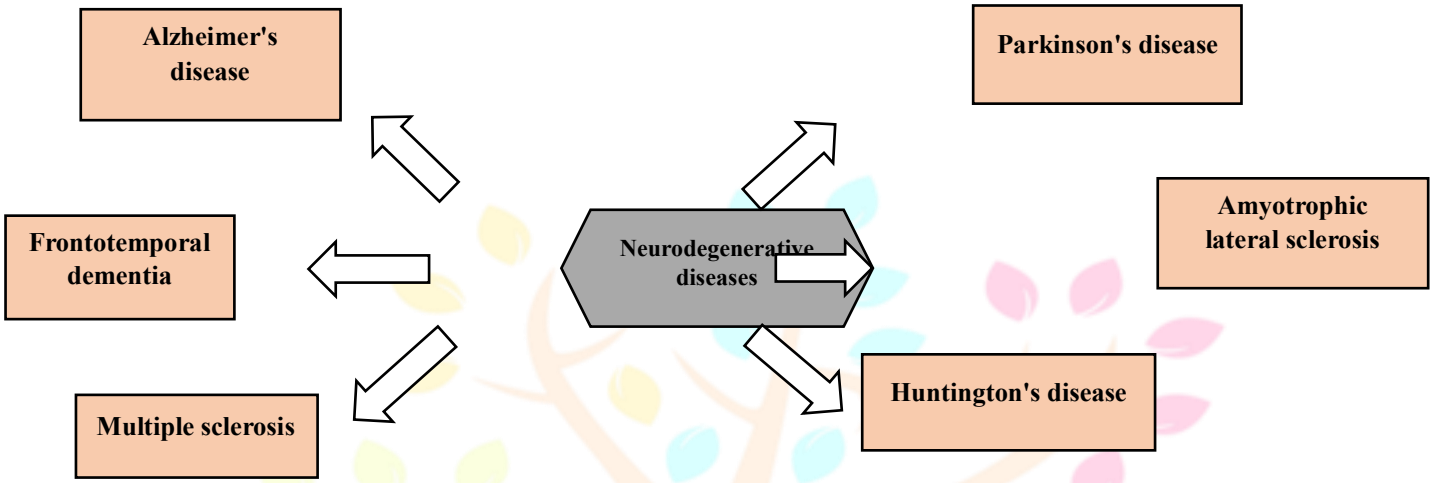


Fig.1: Pie diagram of Neurodegenerative diseases

2.HERBAL DRUGS USED FOR NEURODEGENERATIVE DISEASES.

Herbs have been used in traditional medicine for generations to help people with neurodegenerative diseases maintain their health and well-being. While scientific evidence for the efficacy of herbs in the treatment of neurodegenerative diseases is limited, and further research is needed, some herbs have showed promise in preclinical or clinical investigations. Herbs should be used under the supervision of a skilled healthcare expert and should not be used as a substitute for normal medical care. Here are several herbs (Fig.2) that have been researched for their potential advantages in neurodegenerative diseases.

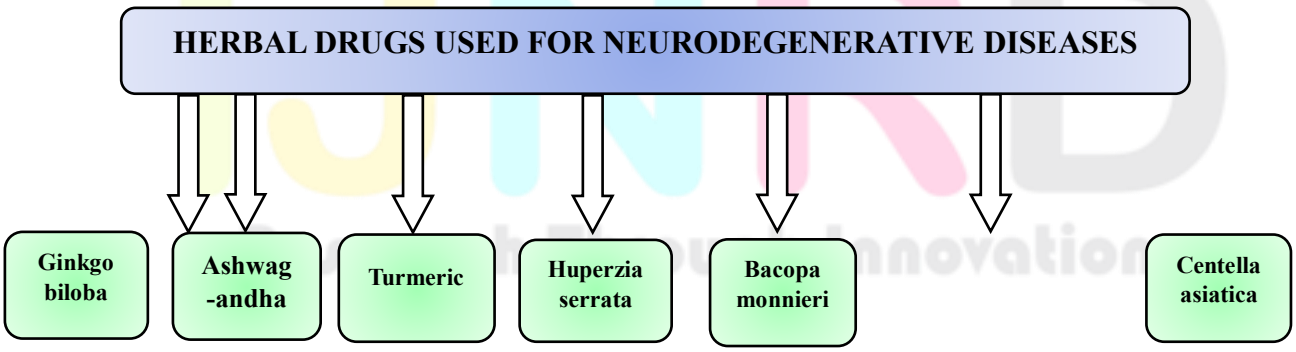


Fig.2: Pie diagram of herbal drugs used for neurodegenerative diseases

1. **Ginkgo biloba:** Ginkgo biloba is a well-known herb with antioxidant and anti-inflammatory effects. It has being explored for its possible benefits in neurodegenerative illnesses such as Alzheimer's and Parkinson's. More research, however, is required to determine its usefulness.
2. **Ashwagandha (Withania somnifera):** Ashwagandha is an adaptogenic herb that has been explored for its possible neuroprotective properties in Ayurvedic medicine. It possesses antioxidant, anti-

inflammatory, and anti-stress qualities, and it has been proposed that it could help with neurodegenerative illnesses like Alzheimer's and Parkinson's.

3. **Turmeric (Curcuma longa):** Turmeric is a spice often used in Indian cuisine that has been researched for its possible anti-inflammatory and antioxidant qualities. Curcumin, the main ingredient in turmeric, has been demonstrated to have neuroprotective properties in preclinical tests and has been reported to have potential advantages in neurodegenerative illnesses.
4. **Bacopa monnieri:** Brahmi, commonly known as Bacopa monnieri, is an Ayurvedic herb noted for its possible cognitive-enhancing benefits. It's being researched for its possible benefits in enhancing cognitive function and memory in neurodegenerative disorders like Alzheimer's.
5. **Centella asiatica (Gotu Kola):** Gotu kola is a herb used in traditional medicine for its potential cognitive-enhancing benefits. It has been examined for its potential neuroprotective effects and has been proposed to help with neurodegenerative illnesses like Alzheimer's.
6. **Huperzia serrata:** This herb is renowned for its possible acetylcholinesterase inhibiting properties, which may be beneficial in neurodegenerative illnesses like Alzheimer's. It has being investigated for its potential cognitive-enhancing properties.

While herbs may offer potential benefits in neurodegenerative diseases, additional research is needed to determine their safety and efficacy. Herbal remedies should be taken with carefully and under the supervision of a skilled healthcare practitioner because they may interact with pharmaceuticals, cause adverse effects, and their safety and efficacy may vary based on individual circumstances.[5,6,7,8]

3.Curcumin

Turmeric (Curcuma longa) (fig.3) is a tropical herbaceous rhizomatous plant of the Zingiberaceae family. It is indigenous to the Indian subcontinent and Southeast Asia. The dried and powdered rhizome produces a bright orange-yellow powder known as Indian saffron, yellow ginger, or yellow root. Turmeric powder is a popular spice in South and Southeast Asian cuisine, and it is one of the main ingredients of curry powder.[9,10]

Fig.3: Turmeric and Curcumin

3.1Pharmacokinetics of curcumin.

The pharmacokinetic properties of routinely delivered medicines are largely responsible for their efficacy. The voyage from the point of administration to the target site (in this case, the brain) is a perilous one that does not always favour the therapeutic molecules. The presence of numerous plasma proteins contained therein is the initial point of interest. Some medications are heavily attached to these proteins, limiting the amount of drug available in circulation and, as a result, lowering the amount of free drug available for delivery to the brain. Furthermore, certain medications are rapidly cleared by the major clearance organs, leaving only a handful in the bloodstream. Furthermore, drug absorption is limited by the interaction between drug and target cells. More specifically, pharmacological compounds can have an effect on cells that results in channel blockage, a change in membrane potential, or even a change in cell shape. This transitory action can limit the cell's behaviour and absorption of the delivered chemical molecule. Small lipophilic pharmacological compounds are often favourable for brain delivery. [11,12,13,14]

3.2 STRUCTURE:

Curcumin (Fig.4) is a symmetric molecule with chemical formula C21H20O6 and molecular weight 368.38. It consists of three chemical entities in its structure: two aromatic ring systems containing o-methoxy phenolic groups, linked by a seven-carbon linker consisting of an α, β-unsaturated β-diketone moiety.

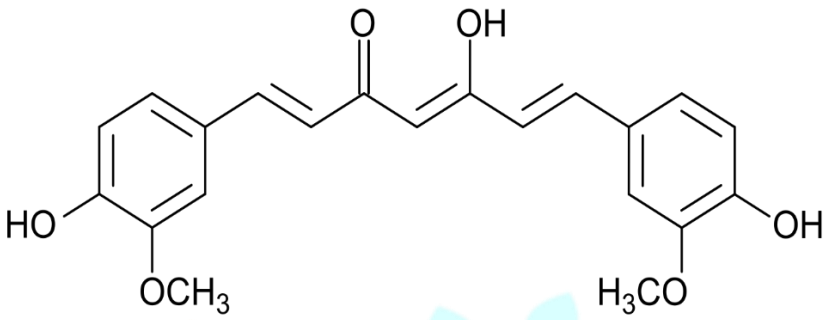


Fig.4: Structure of Curcumin

3.3 Extraction process of curcumin: by soxhlet apparatus (Fig.5)

3.3.1 Requirements: Soxhlet apparatus

Curcuma longa (dried rhizomes of turmeric)

3.3.2 Chemicals:

95% alcohol, Benzene, 0.1%NaOH, Dil.Hydrochloric acid, Distilled water

3.3.3 Process of Extraction:

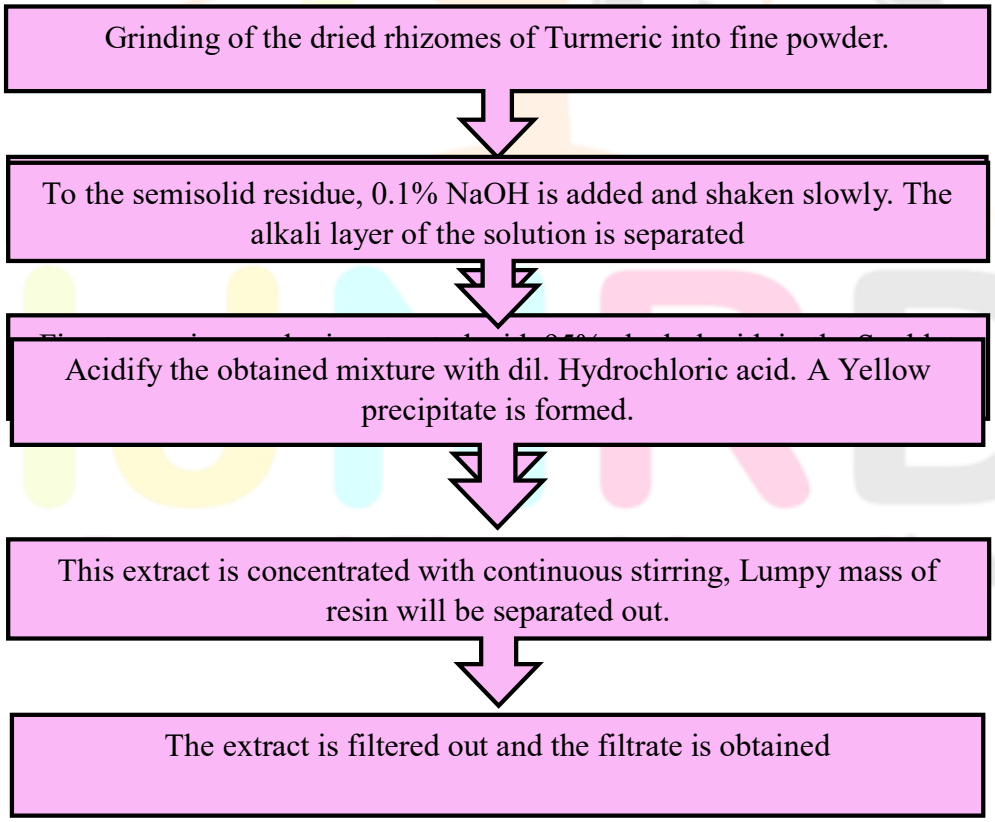


Fig.5 Extraction process of curcumin by Soxhlet apparatus

3.4 Procedure of preparation of Nasal Spray:

1. Curcuma extract is prepared by firstly dissolving the pure curcumin crystals in then organic solvents i.e. Dimethyl sulfoxide (DMSO), ethanol, methanol, chloroform or acetone.
2. To the extract solution we add Methyl sulfonilmethane, Xylitol, glutamine and oleuropein and stir well.
3. To the above mixture add colloidal silver which acts as a preservative and anti-inflammatory agent.
4. Then add panthenol, vitamin B3 and Allantion to the mixture and stir for 30 mins and keep it at room temperature (25°C)
5. Now finally add acacia Senegal gum to the purified water and keep mixture aside for 10 mins as the mixture will become clear
6. Add the gum mixture to the preparation and mix it well.
7. Now to make the sufficient quantity add purified water to mixture.
8. Transfer the mixture to the respective container with an appropriate nozzle.

3.4.1 Ingredients from the marketed preparations:

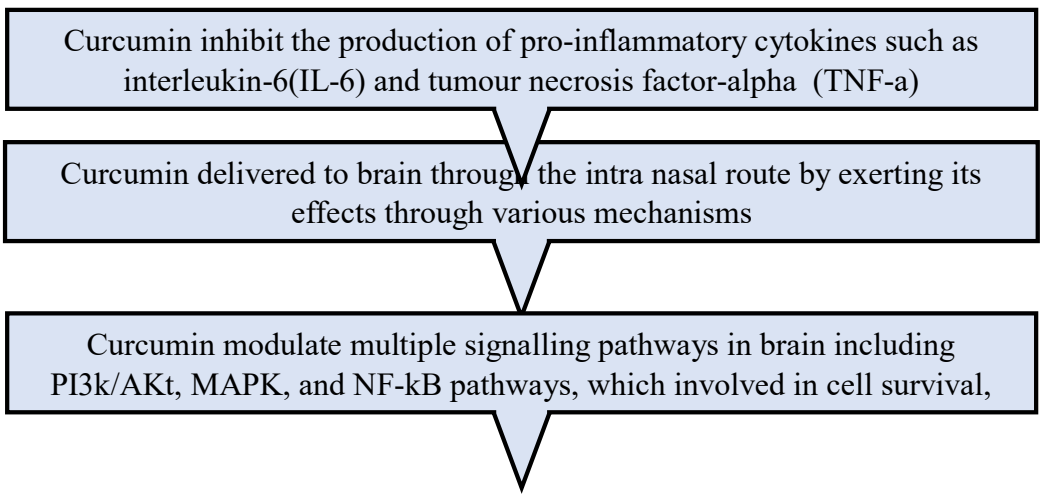
Table.1: Ingredients and its uses of curcumin nasal spray.

Ingredients	Use of ingredients
Purified water	solvent
Colloidal silver	Anti-inflammatory effect
Curcuma extract(Curcuma longa)	Active Pharmaceutical Ingredient
Oleuropein	Antioxidant
Methyl sulfhonilmethane	Anti-Allergic
Xylitol	Nasal decongestant
Glutamine	Immune booster
Panthenol (provitamin B5)	Prevent dryness of nasal mucosa
Vitamin B3 (Niacinamide)	Nasal decongestant
Allantoin	Anti-Allergic
Acacia Senegal gum	Smooth mucosal membrane

3.5 Mechanism of action

The intranasal route of administration allow for direct delivery of curcumin to the brain through the olfactory system bypassing the blood brain barrier

The olfactory epithelium is rich in receptors and enzyme that facilate the transport of molecule from the nasal cavity of the brain, making intranasal delivery an attractive method for targeting brain disorders.



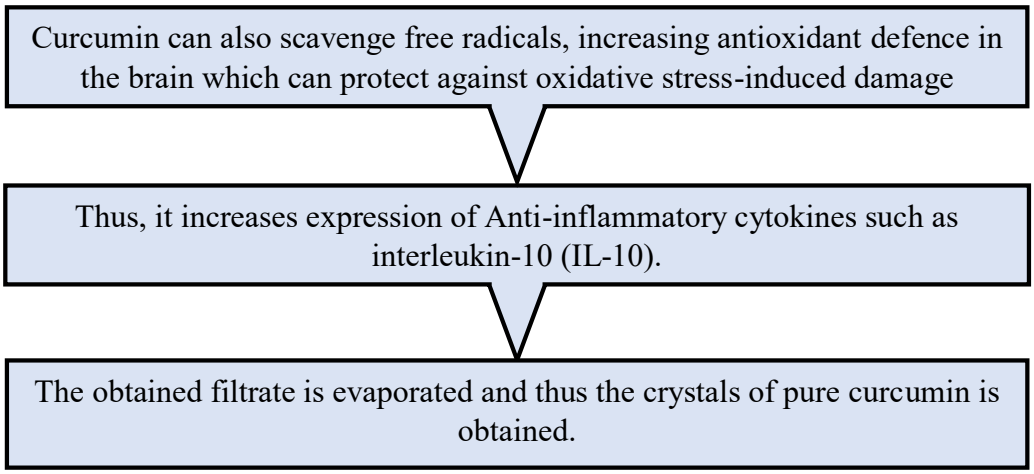


Fig.6: Mechanism of action of curcumin.

3.6 Safety

Curcumin and Curcuma longa Extract did not increase the occurrence of adverse events in RCTs that reported them. The Food and Agriculture Organisation of the United Nations/World Health Organisation (FAO/WHO) and European Food Safety Authority (EFSA) report that the acceptable daily intake (ADI) value of curcumin is 0-3 mg/kg; it is also approved as a botanical by the US Food and Drug Administration. According to the relevant safety and toxicity clinical research, the highest effective dose of curcumin is 4-8 g/d. Curcumin at 8 g/d was demonstrated to be safe in both phase I and II clinical trials, and curcumin at 12 g/d has been reported to be tolerated by humans. Curcumin has been demonstrated in studies to have no clear sub-chronic toxicity harm after animal toxicity tests, as well as no potential mutagenic or teratogenic effects.

Krishnaraju *et al*., for example, used acute oral administration, acute cutaneous, primary skin and eye irritation, and dose-dependent 90-day sub chronic toxicity studies to assess the safety of dimethyl curcumin (DC). They discovered that the acute oral median lethal dose (LD_{50}) of DC in female SD rats was greater than 5000 mg/kg, and the acute dermal LD50 was greater than 2000 mg/kg, with no weight change or deleterious effects reported after autopsy, demonstrating DC's broad-spectrum safety. P. Dandekar et al. investigated the toxicity of curcumin-loaded nanoparticles. Acute toxicity studies revealed that a dose of 2000 mg/kg was non-toxic, while subacute toxicity studies revealed that long-term administration at the standard therapeutic level of 100 mg/kg curcumin and twice the therapeutic dose was safe.[15,16,17,18,19]

3.7 Uses

1. Curcumin has been proven to have anti-amyloid and anti-tau effects, both of which are hallmarks of Alzheimer's disease. Curcumin has been shown to reduce the formation of beta-amyloid plaques and tau tangles, which cause brain cell degeneration in Alzheimer's disease.
2. Curcumin possesses antioxidant and anti-inflammatory characteristics that may help guard against oxidative stress and inflammation, both of which are important factors in the development of Parkinson's disease. Curcumin has been proven to protect dopaminergic neurons against degeneration, which are notably harmed in Parkinson's disease.
3. Multiple sclerosis (MS): Curcumin possesses anti-inflammatory and immunomodulatory qualities, which may aid in the reduction of inflammation and immune system activity in MS. Curcumin has been found in animal models of MS to help reduce the intensity of symptoms.

4. Curcumin has been demonstrated to have neuroprotective properties in animal models of Huntington's disease, a rare hereditary illness that causes progressive brain cell degeneration. Curcumin has been shown in animal models of Huntington's disease to reduce oxidative stress and inflammation in the brain while also improving motor performance.
5. Curcumin has been demonstrated to have anti-inflammatory, antioxidant, and neuroprotective characteristics that may be beneficial in ALS patients. Curcumin has been shown in animal models of ALS to help reduce inflammation, oxidative stress, and neuronal death.
6. Stroke: Curcumin has been demonstrated to have neuroprotective benefits in animal models of stroke, a condition in which the brain's blood supply is compromised. Curcumin has been shown in stroke models to lower brain damage, inflammation, and oxidative stress, which may help improve outcomes.[20,21,22]

4. Ashwagandha

Withania somnifera (Solanaceae), also known as Ashwagandha or Indian ginseng, is extensively spread in India, Nepal, China, and Yemen. The roots of the plant contain active phytoconstituents, primarily withanolides, alkaloids, and sitoindosides, and are traditionally used to treat a variety of brain problems.[23]

Fig.7. Roots and Leaves of Ashwagandha

4.1 Pharmacokinetics of ashwagandha

Ashwagandha (Withania somnifera) is a medicinal plant used in traditional medicine, particularly in Ayurvedic medicine. The absorption, distribution, metabolism, and elimination of ashwagandha's active components in the body are referred to as its pharmacokinetics.

Several investigations on the pharmacokinetics of ashwagandha in humans and animals have been conducted. Ashwagandha contains a variety of active chemicals, such as withanolides, alkaloids, and flavonoids, each with a unique pharmacokinetic profile.

4.1.1 Absorption: Ashwagandha is mostly taken orally, and its active components are absorbed in the gastrointestinal tract. The rate and degree of ashwagandha absorption are affected by dosage, formulation, and individual characteristics such as gut health and the availability of food.

4.1.2 Distribution: Ashwagandha's active components are transported throughout the body after absorption, including the brain, liver, and kidneys. The main active chemicals in ashwagandha, withanolides, have been proven to accumulate in the brain and nervous system.

4.1.3 Metabolism: The active chemicals in ashwagandha are bio transformed in the liver and other organs. The cytochrome P450 enzymes, which are responsible for the metabolism of numerous medicines and xenobiotics, metabolise withanolides.

4.1.4 Elimination: The active chemicals in ashwagandha are removed from the body via the urine and faeces. Withanolides have a somewhat long half-life, and their elimination rate is affected by characteristics such as age, gender, and health status.

Overall, the pharmacokinetics of ashwagandha are complex and variable. More research is needed to better understand ashwagandha's active components' absorption, distribution, metabolism, and excretion, as well as their possible interactions with other medications and nutrients.[24,25]

4.2 STRUCTURE

The plant ashwagandha (Withania somnifera) belongs to the Solanaceae family. The chemical structure of the active chemicals in ashwagandha varies, however the main bioactive ingredients are a class of compounds known as withanolides. Withanolides are steroidal lactones with a C28 side chain and a 6,7-epoxy ring.

Withanolides are made up of a four-ring steroid backbone with a lactone ring at C22 and a six-membered lactone ring at C28. The lactone ring at C28 is often changed with one or more hydroxyl or acetyl groups, whilst the side chain at C17 varies in length and saturation.

Several withanolides, including withaferin A, withanolide A, withanoside IV, and withanoside V, have been isolated and identified from ashwagandha. Withaferin A is one of the most investigated withanolides, and it has been demonstrated to have anti-inflammatory, anticancer, and neuroprotective properties. Ashwagandha contains various bioactive chemicals, such as alkaloids, flavonoids, and saponins, in addition to withanolides, that contribute to its pharmacological activities.

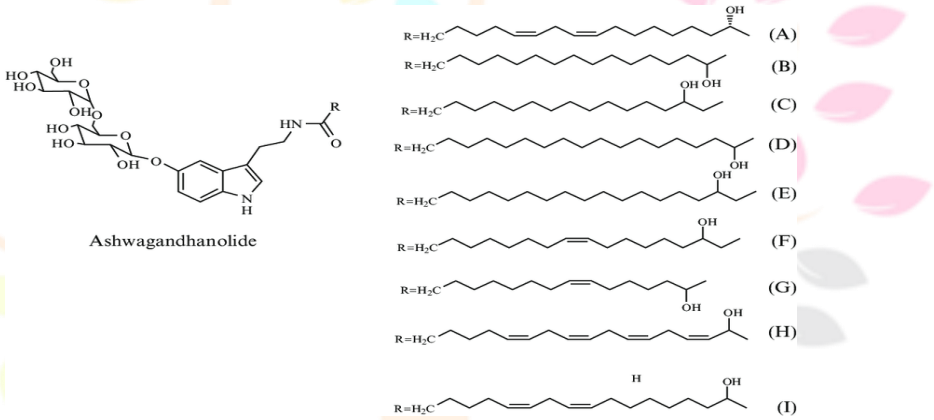


Fig.8. Chemical structure of Ashwagandha

4.3 Extraction of Ashwagandha:

4.3.1 Requirements:

*Withania somnifera (*dried roots of Ashwagandha)

4.3.2 Chemicals:

Ethanol, Methanol, Methyl paraben, propyl paraben, Dicalcium phosphate, colloidal silicon sulphate.

Small pieces of ashwagandha roots sieved on 20 mesh to separate out the foreign

Grind the roots in grinder in 50 mesh to obtain the fine powder this powder is mixed with ethanol and heated at 40 ºC for 12 hrs. with continuous stirring with the help of magnetic stirrer

Both the filtrates are collected and the ethanol is distilled out by heating

Mixture is cooled to room temp. and centrifuged [I]. The residue is then again added to ethanol, heated and refluxed at 95 ºC for 2 hrs.

To the obtained extract at room temp. add mixture of methyl paraben and propyl paraben, dicalcium phosphate, and colloidal silicon dioxide to obtain pasty mass

Stir the mixture and heat at 90-95ºC, till the paste converted to the granular powder

The mixture is cooled and then centrifuged [II].

Fig.9. Extraction of Ashwagandha

4.4 Mechanism of action of Ashwagandha:

- Compounds such as withanolids of Ashwagandha have antioxidant activity which reduce the oxidative stress in brain, a process that occurs when there is an imbalance between free radicals and antioxidants in the body which lead to damage of cells and tissue, this process is known as oxidative stress.
- Ashwagandha also have anti-inflammatory effect, a natural response to a infection or injury by the immune system is inflammation. Chronic inflammation can be a cause or progression of neurodegenerative diseases hence these anti-inflammatory agents may prevent the inflammation related disorders
- It may also promote the growth and survival of neuron, it increase concentration of brain in the growth and survival of neurons.

4.5 Safety

Clinical application of Ashwagandha and its ingredients against neurodegenerative illnesses is predicted to improve such diseases. Some groups have previously claimed that Ashwagandha and its components are safe. Administration of Ashwagandha water extract (100 mg/kg/d)

With drinking water for 8 months, rats showed no harm. A 28-day oral dose of an 80% methanol extract of Ashwagandha (2000 mg/kg/d) revealed no harm. However, oral administration of an alcoholic extract of defatted Ashwagandha seeds caused acute toxicity in mice: the LD50 was 1750 41 mg/kg. In mice, the LD50 after i.p. injection of an ethanol extract of Ashwagandha was 1259 mg/kg.

Given that Ashwagandha has been used in Ayurvedic medicine since ancient times, conventional use of Ashwagandha, including various detoxification procedures, may not result in severe toxicity.

However, given the toxicity of numerous of its constituents, the hazardous chemical content of Ashwagandha should be considered, especially when administered in large quantities.[26,27,28]

4.6 Uses of ashwagandha

Ashwagandha, also known as Withania somnifera, is a plant that is extensively used in Ayurvedic medicine. It has been proven to have a number of health benefits, including potential neuroprotective effects that could aid in the treatment of neurodegenerative disorders.

1. **Alzheimer's Disease:** Ashwagandha may be helpful in the treatment of Alzheimer's disease by reducing the accumulation of beta-amyloid plaques in the brain, which are a hallmark of the disease. It may also help to improve cognitive function and memory in those with Alzheimer's. Alzheimer's patients' cognitive abilities and memories may potentially benefit from it.
2. **Parkinson's Disease:** By defending the brain's dopaminergic neurons, which are harmed by the disease, ashwagandha may be helpful in treating Parkinson's disease. Inflammation and oxidative stress in the brain, which both contribute to the onset and progression of Parkinson's, may also be lessened by it.
3. **Huntington's disease:** By lowering brain cell damage and enhancing cognitive function, ashwagandha may be useful in the treatment of Huntington's disease. Inflammation and oxidative stress, which both contribute to the onset and progression of Huntington's disease, may also be lessened.

5. Ginkgo biloba:

Ginkgo biloba, also called the maidenhair tree or ginkgo (/ko, ko/ GINK-oh, -goh), is a species of tree that is indigenous to China. In the order Ginkgoales, which initially arose more than 290 million years ago, it is the last surviving species. The Middle Jurassic, some 170 million years ago, produced fossils of the genus Ginkgo that are strikingly identical to the surviving species today. Early in human history, the tree was domesticated, and it is still widely planted today.

There is no scientific proof that ginkgo leaf extract supports human health or is useful against any diseases, despite the fact that it is frequently used as a dietary supplement.[29,30]

Fig.10.Fruits and Leaves of Ginkgo biloba

5.1 Pharmacokinetics of Ginkgo biloba

Ginkgo biloba is a herbal supplement that is frequently used for its conceivable benefits to memory and cognition. The pharmacokinetics of Ginkgo biloba pertains to the body's absorption, distribution, metabolism, and excretion of the herb's active ingredients.

5.1.1 Absorption: Ginkgo biloba is commonly used orally as tablets, capsules, or extracts. Flavonoids and terpenoids, which are absorbed in the stomach and small intestine, make up the majority of the Ginkgo biloba's active ingredients. Food can influence the absorption of these substances since Ginkgo biloba's bioavailability can be increased when taken with a high-fat meal.

5.1.2 Distribution: The Ginkgo biloba's active ingredients are dispersed throughout the body after absorption. They exist in the brain and other tissues and can penetrate the blood-brain barrier.

5.1.3 Metabolism: Ginkgo biloba's active ingredients are metabolised in the liver. While terpenoids are predominantly metabolised by cytochrome P450 enzymes, flavonoids are primarily metabolised via glucuronidation and sulfation.

5.1.4 Excretion: Ginkgo biloba's metabolites are mostly eliminated through the urine and faeces. The active compounds' elimination half-lives range from 3-6 hours.

It's important to remember that Ginkgo biloba's pharmacokinetics can change depending on the supplement's formulation, dosage, and individual characteristics like age, gender, and health state. Ginkgo biloba may not be suitable for everyone and can interact with some drugs, so it's crucial to speak with a healthcare professional before using it.

5.2 Structure

Particularly, ginkgolide B is a diterpenoid trilactone with six rings containing five members. It has a particularly unique tert-butyl group at one of the rings, a spiro[4,4]-nonane carbocyclic ring, and a tetrahydrofuran ring (Figure 1). In 1932, the class of ginkgolides was first discovered in the Ginkgo biloba tree.(fig.11)

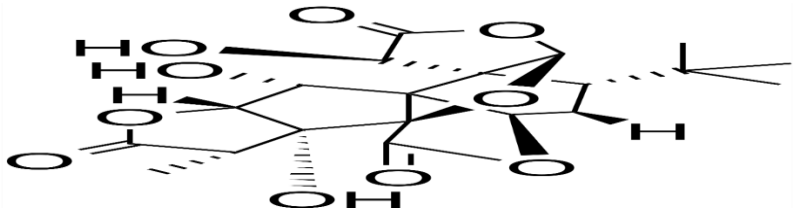


Fig.11. Structure of Ginkgo biloba

5.3 Extraction on Ginkgo biloba

5.3.1 Requirements

Ginkgo biloba (Leaves of plant)

5.3.2 Chemicals:

Acetone, Ammonia Solution, sulphuric acid, Butanone, Acetone Ammonium Sulphate, Ethanol.

5.3.3 Process of Extraction:

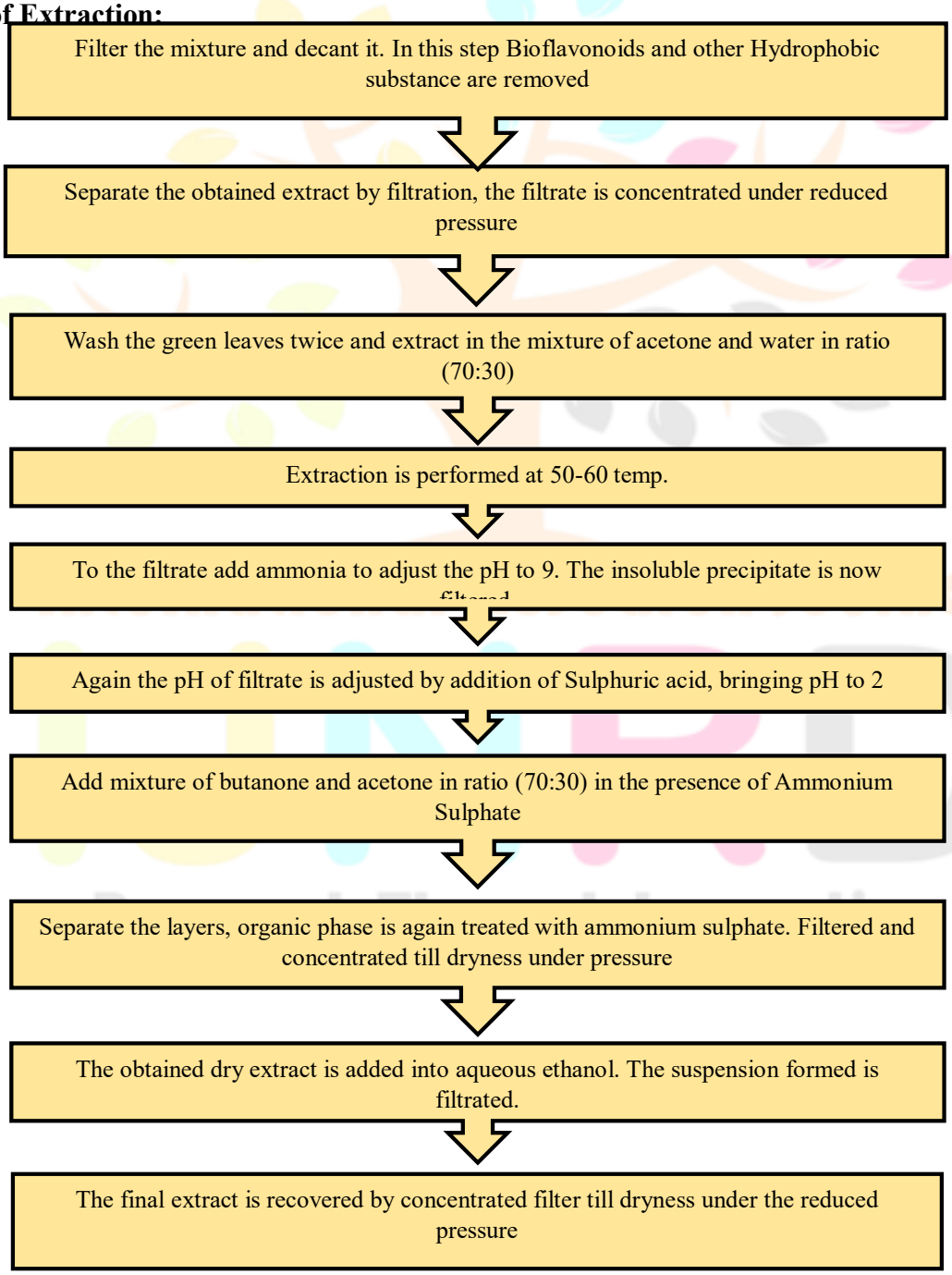


Fig.12.extraction of of ginkgo biloba

5.4 Mechanism of action of ginkgo biloba:

- Ginkgo biloba may aid short-term memory by lowering the formation of free radicals in the prefrontal cortex, which would support its neuroprotective properties.
- As a free radical scavenger, gingko biloba also works to protect neurons from oxidative stress and programmed cell death brought on by ageing, cerebral ischemia, and other neurodegenerative conditions.
- Ginkgo biloba reduces the neurotoxicity caused by amyloid and offers protection from the effects of hypoxia and elevated oxidative stress.
- Additionally, it may control metabolism, maintain the membrane, and encourage vasodilation.

5.5 Safety

None of the secondary outcome indicators (ESR, CBC, glucose, urea, creatinine, transaminases, bilirubin, sodium, potassium, chlorides, HDL, LDL, triglycerides, APTT, and PV; P>0.05 for all) showed a statistically significant difference between the G. biloba and placebo groups at the conclusion of the study. Physical and neurological data between the G. biloba and placebo groups did not differ statistically (P>0.05 for all). Additionally, there was no statistically significant difference in compliance or early departure from the study between the G. biloba and placebo groups. In terms of concurrent therapy, the participants were most likely to take nonsteroidal anti-inflammatory drugs (apart from acetylsalicylic acid), cardiovascular disorders, and neurological conditions.

5.6 Uses

Popular herbal supplement ginkgo biloba is thought to have a number of health advantages. According to several studies, ginkgo biloba may have some advantages when it comes to neurodegenerative diseases. Here are a few applications for ginkgo biloba in neurological diseases.

1. **Alzheimer's disease:** According to certain research, ginkgo biloba may improve memory and cognitive performance in Alzheimer's disease patients. Other research, nevertheless, has not discovered any appreciable advantages.
2. **Parkinson's disease:** Ginkgo biloba may have neuroprotective effects in Parkinson's disease, according to some data, although further research is required in this area.
3. **Dementia**: Although the evidence is conflicting, several studies have suggested that ginkgo biloba may improve cognitive function in dementia patients.
4. **Multiple sclerosis:** Ginkgo biloba has been investigated for its potential neuroprotective properties in multiple sclerosis, but further study is required to determine whether it is a useful treatment.
5. All things considered, additional study is required to completely comprehend the potential advantages of ginkgo biloba in neurodegenerative diseases. Before beginning any new supplement, it's crucial to speak with a healthcare professional, especially if you use medication or have a medical condition.

Conclusion

Based on the foregoing, it is not unreasonable to speculate that curcumin's anti-inflammatory qualities are at least largely responsible for its antidepressant and neuroprotective benefits. However, there are a few critical considerations to consider in this regard. The first point concerns curcumin bioavailability, as dietary curcumin has low bioavailability . This could be due to a variety of issues such as curcumin's insolubility in water, poor absorption, and quick metabolism, all of which must be addressed for a more significant therapeutic intervention with curcumin.

We gained new insights for the therapy of neurodegenerative disorders using ashwagandha extracts and similar chemicals; for example, modulating astrocyte characteristics can lead to the recovery from functional disability in spinal cord injury, and impacts on peripheral organs may cause the brain's A levels to be cleared. Direct targets of Ashwagandha-related substances have not yet been discovered, nevertheless. Identification of new targets for the treatment of neurodegenerative disorders may result from clarification of these problems. Additional research on Ashwagandha will likely help meet a critical medical need for effective therapies that could treat neurodegenerative disorders.

The idea that standardised Ginkgo biloba extract EGb761 may be useful in the treatment and prevention of AD and other age-related, neurodegenerative illnesses is supported by a number of in vivo and in vitro preclinical investigations. Possible mechanisms of action include inhibition of oxidative stress, inhibition of apoptosis, inhibition of inflammation, inhibition of amyloidogenesis and A aggregation, inhibition of ion homeostasis, inhibition of tau protein phosphorylation, and even stimulation of growth factors. The clinical effectiveness of EGb761 is still unknown, though. Overall, a deeper comprehension of the processes behind EGb761's neuroprotective benefits may help us better comprehend the potency and complexity of this medication. It may also be useful for developing treatment approaches in future clinical practise.

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