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HERBAL THERAPEUTIC AGENT AS AN ALTERNATIVE FOR SYNTHETIC MEDICINES – NUTRACEUTICALS A REVIEW

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ABSTRACT

The practice school is the preliminary step of our project work, and I opt for Pharmacognosy as my major domain. The objective of practice school was to encourage a partnership and intellectual exchange between academic and industry.

The Practice School report contains 4 modules. The first Module includes introduction to the topic. It discusses the importance of herbal therapeutic agents and nutraceuticals in modern healthcare. Herbal medicines, derived from natural plant sources, are used as safer alternatives to synthetic drugs due to their therapeutic benefits and fewer side effects. The study explains traditional systems of medicine, phytochemicals, mechanisms of action, and synergistic effects of herbal formulations. It also highlights the role of nutraceuticals in disease prevention and management through antioxidant, anti-inflammatory, and gut health–supporting activities. Overall, the project emphasizes the growing clinical relevance, future potential, and challenges of herbal therapeutics and nutraceuticals in improving human health.

INTRODUCTION

Herbal therapeutic agents are medicinal products derived from plants that are used to prevent and treat various diseases. They have been used for centuries in traditional systems of medicine such as Ayurveda, Traditional Chinese Medicine, and Unani. In recent years, herbal medicines have gained attention as alternatives to synthetic drugs due to their natural origin, lower cost, cultural acceptability, and generally fewer side effects when used appropriately.

Unlike synthetic medicines, which are often chemically manufactured and may cause adverse reactions, herbal remedies contain bioactive compounds that work in harmony with the body. Many modern drugs, such as aspirin and digitalis, have originated from plant sources. Therefore, herbal therapeutic agents play an important role as complementary or alternative options in modern healthcare.[1]

MODULE I

1.1 HISTORY AND EVOLUTION OF HERBAL MEDICINES

Herbal medicine has been used for thousands of years in many ancient cultures, including **Indian, Chinese, Egyptian, Greek, and Roman** civilizations. Written records show that people were using plant-based remedies as far back as about **5,000 years ago**. In India, some of the earliest and most important medical writings are found in the **Rig-Veda and the Atharvaveda**, which include references to healing plants and treatments. These teachings later became more detailed in the classical Ayurvedic texts such as the **Charaka Samhita and the Sushruta Samhita**, which describe hundreds of herbs and how they were used to treat many illnesses. Ancient literature from these traditions mentions the use of herbs for age-related conditions like memory loss and osteoporosis, as well as for problems such as wounds in diabetics, immune system disorders, and liver diseases. Among these, **Ayurveda** stands out as one of the oldest medical systems that is still practiced today in India, Sri Lanka, and other countries. Herbal medicine remains a primary source of healthcare for about 75–80% of the world's population, especially in developing countries, due to its cultural acceptance, natural origin, and relatively fewer side effects. Many modern medicines are derived from plants, and around 25% of prescription drugs contain plant-based active ingredients.

Evolution of Herbal Medicine: Medicinal herbs are used to treat many different illnesses, which may seem doubtful from a modern medical perspective. However, many herbs contain multiple helpful properties—such as anti-inflammatory, antimicrobial, immune-supporting, and pain-relieving effects. Because they act in several ways at once, a single herb can benefit different conditions. Even if not a perfect cure, herbs may reduce symptoms or prevent complications, helping the body recover [2]

- **Example of evolution of herbal medicine:**

Ginseng was discovered in the mountains of Northern China over 5000 years ago and was likely first used as food. It has been used medicinally for more than 3000 years and was mentioned in the ancient Chinese herbal **Shenlong Benaco Jing** (around 100 AD). It was

believed to strengthen the body, support vital organs, improve mental clarity, and promote long life when taken regularly. Ginseng was later found growing in parts of the United States such as New England, New York, Massachusetts, and Vermont.

Fig.01: Ginseng.

1.2 TRADITIONAL SYSTEM OF MEDICINE

Kerala is the first state in India to officially separate and promote traditional systems of medicine such as Unani, Ayurveda, Homeopathy, and Siddha. These systems focus on holistic healing and have deep cultural roots. Disease not only affects the physical health of individuals but also impacts families and the wider community. Illness and death create economic burdens, emotional distress, and social disruption. Therefore, maintaining good health and ensuring proper treatment for the sick are essential for the well-being and stability of society.

The major traditional systems of medicines are;

a) Ayurvedic system of medicine
b) Unani system of medicine
c) Siddha system of medicine
d) Homeopathy system of medicine

a) Ayurvedic System [3]

The term Ayurveda means 'Science of Life'. Health in Ayurveda is defined as a well-balanced and a happy state of being. Disease is also considered four folds i.e. body, mind, external factors and natural intrinsic causes. The treatment is done by use of drugs, diet and practices. Its approach is that disease occurs due to imbalance in the equilibrium of three doshas, restoration of which eliminates the disease. Thus, it aims at not only curing the

disease but also enhancing the body vitality to combat the disease and strengthen the immune system so the disease is automatically cured or prevented.

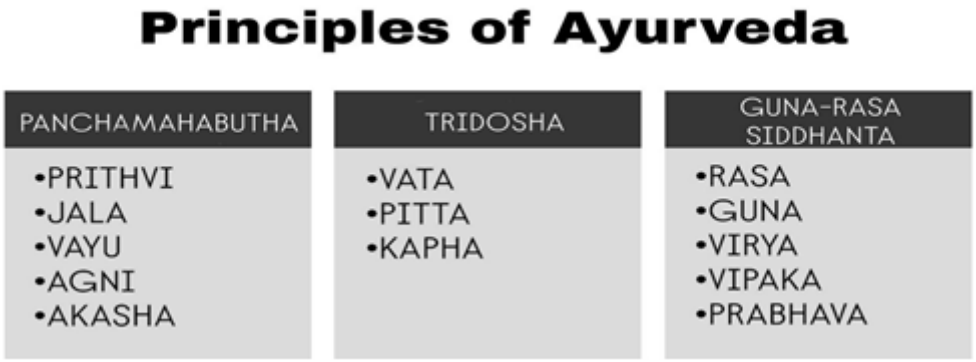


Fig.no 2: Principles of Ayurveda.

Vata: it regulates the psychic and nervous system Imbalance of this leads to disease of ENT, heart, urinary tract, skin etc.

Pitta: it regulates energy production, digestion, tissue building etc. Imbalance of this leads to disease like acidity, indigestion, liver and skin disease.

Kapha: it regulates heat, formation of fluids, mucous etc. Imbalance of this results in joint pain, brain disease, drowsiness etc.

➢ According to Panchamahabhutas in Ayurveda, the human body is composed of five basic elements:

- Prithi (Earth)
- Jala (water)
- Vayu (Air)
- Agni (Fire)
- Akasha (Sky)

➢ Combination of these five elements from seven basic tissue of the body which are referred as ‘Sapta Dahu’which are as follows,

- Rasa (Lymph or plasma)
- Raktha (Blood)
- Mamsa (Flush)
- Meda (Fat)
- Asti (Bones)

- Majja (Marrow)
- Shukra (Reproductive organ)

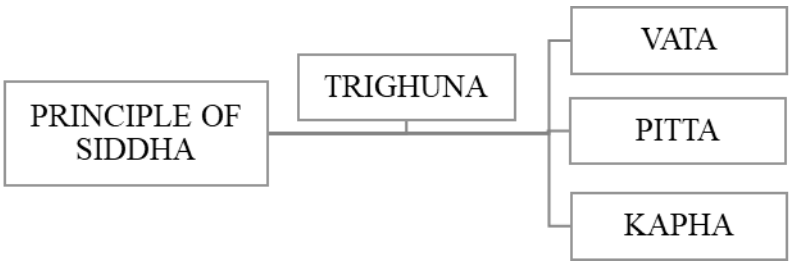
b. Unani System of Medicine [4]

Unani medicine believes that every person has a natural self-healing power called defence constitution (Tabiyat). This power protects the body and maintains health. When it becomes weak, disease occurs. Unani treatment helps to restore this natural balance through proper diet, therapy, and medicines.

Principle of Unani Medicine

C. Siddha System of Medicine [5]

Siddha system was practised in south India especially Tamil Nadu. This system is believed to be older than Ayurveda and the latter was derived from Siddha system. “Agastya" believed to be the father of Siddha medicine.



It is based on three principles Vata, Pitta and Kapha, which are known as "Trigunas".

- **Vata:** People with predominant Vata are characterized by stout, black, cold and inactive personalities. Increased Vata develops flatulence, acidity, obesity, heart attacks, etc.

- **Pitta:** People with predominant pitta are characterized by lean, whitish complexioned ha personalities. Increased pitta shows early greying of hair, reddish eyes, burning chest, mental derangement, anaemia.
- **Kapha:** People with predominant kapha are characterized by well built, good complexioned well-behaved personalities. Increased kapha leads to jaundice, heart attack, high fever anaemia, etc [7]

d. Homoeopathic System of Medicine [6]

Homoeopathy is the system of treatment based on scientific methods and demonstrable laws and principles, which are;

Law of similars: Substances which are the cause of disease or produce similar symptoms in healthy individuals can be used to cure the disease in patients (Vaccines) **Law of Direction of Cure,** states that healing progresses from more vital organs to less vital parts, moving from inside to outside and from mental to emotional to physical levels.

Law of Single Remedy: states that only one medicine should be given at a time, chosen according to the patient's total symptoms, as only the most similar single remedy can effectively support the body's defence mechanism.

Law of minimum dose: This rule states that dose of the drug is inversely proportional to its potency (lower the dose, more potent the drug is).

1.3 COMPARISON BETWEEN HERBAL THERAPEUTICS AND SYNTHETIC MEDICINES

Herbs/medicinal plant/homemade remedies are less expensive than the synthetic drugs and majority peoples in rural/backward area have blind faith on them. They are right because they can treat any disease by using them without any lethal side effects. Homemade remedies are not only useful for the treatment of different diseases but are also widely used for enhancing beauty and for curing skin related issues.

On the other hand, synthetic drugs synthesized by employing different methodologies in the laboratory and these are the medicines which are not found in nature. Although herbal medicines are less potent in comparison to synthetic drugs in some cases but still these're consider less toxic or having less side effect in contrast to synthetic drugs. They ultimate norm for any medicine (human made or natural) is their nontoxicity, effectiveness, specificity, stability and potency. Herbal drugs are useful in deliberated holistic therapy for cure of almost all ailments.

1.4 CURRENT GLOBAL ACCEPTANCE OF HERBAL MEDICINES

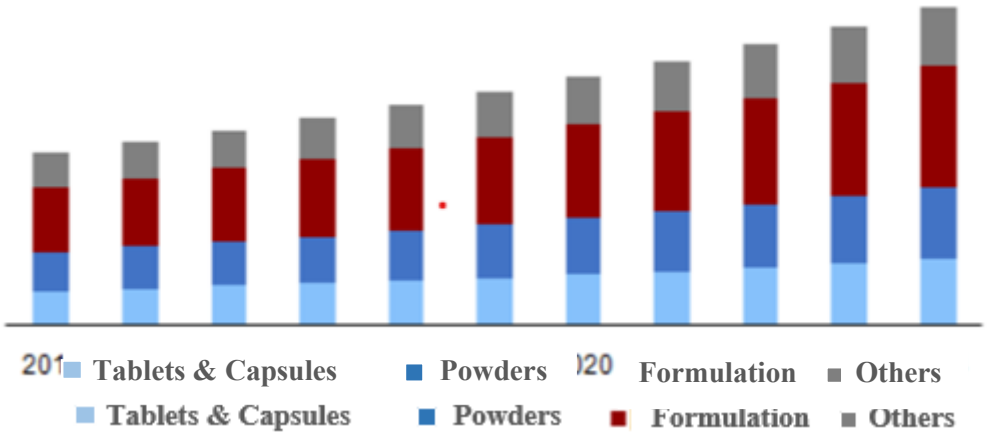


***Fig.3*: Graph Showing the Projected Growth of The Herbal Medicine Market.**

Natural plant extracts contain diverse phytochemicals that can produce important pharmacological effects in the human body. Traditional healing systems such as Ayurveda and Traditional Chinese Medicine have relied on plant-based therapies for thousands of years to treat infections and maintain health. Ayurveda, with a history of about 5,000 years, uses herbal formulations along with minerals, metals, and animal-derived ingredients. [10]

Historically, conventional medicinal practices were based on empirical observations and Remedies have regained popularity due to the rise in chronic diseases and increasing interest in holistic healthcare. Despite their long history and widespread use—especially in countries like the United States—herbal medicines are sometimes criticized by medical experts for lacking strong scientific validation in contemporary medicine.

(a) (b) (c)

Fig. no.4: (a) Rosemary water, (b) Turmeric powder and (c) Tredha herbal oil and shampoo

MODULE II

2.1 PHYTOCHEMISTRY AND PHARMACOLOGICAL BASES [8]

Plant chemicals that protect plant cells from environmental hazards such as pollution, stress, drought, UV exposure and pathogenic attack are called as Phytochemicals.They are biologically active, naturally occurring chemical compounds found in plants, which provide health benefits for humans. Phytochemistry involves studying plant-derived secondary metabolites (alkaloids, flavonoids, terpenoids, phenolics) for their structure, biosynthesis, and medicinal activity, while the pharmacological basses explain their therapeutic effects through interaction with receptors, enzymes, and cells. These compounds act as potent, bioactive ingredients against diseases (e.g., anti-inflammatory, anticancer). They protect plants from disease and damage and contribute to the plant's colour, aroma and flavour. the plant chemicals that protect plant cells from environmental hazards such as pollution, stress, drought, UV exposure and pathogenic attack are called as phytochemicals.

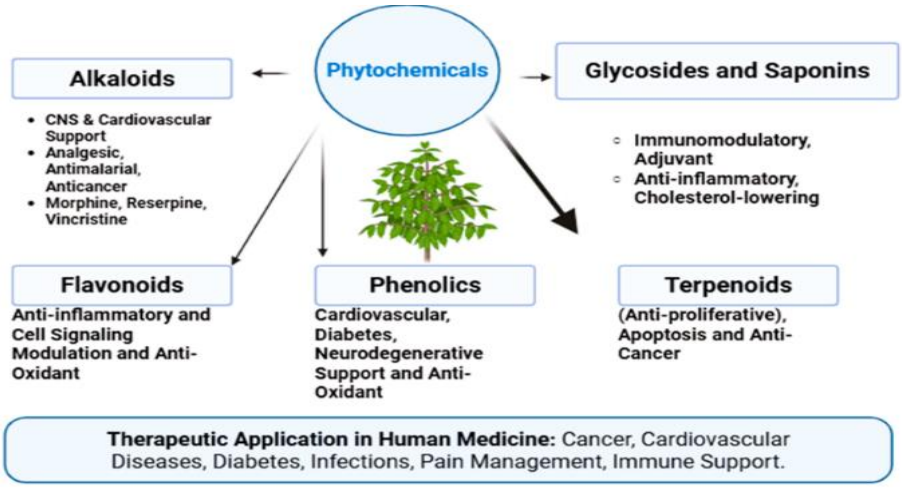


Fig.no.5: Phytochemistry and Pharmacological bases [11]

2.2 ACTIVE PHYTOCHEMICAL CONSTITUENT [4]

phytochemicals are divided into two categories. primary and secondary metabolites based on their role in different metabolic processes. Primary metabolites are involved in primary processes such as respiration, growth, cell division, photosynthesis and food storage. secondary metabolites are derived from primary metabolites in a very small amount, usually at a certain growth stage or to serve a specific function. Secondary metabolites provide the ability to defend against biotic and abiotic stress in plants. Plant secondary metabolites are broadly divided into three categories: Alkaloids, Glycosides, Terpenoids, and Phenolics.

❖ ALKALOIDS

Alkaloids are nitrogen-containing compounds which are widely distributed among large number of plant families. These compounds can be found in the whole plant or sometimes in a specific part of the plant. Alkaloids contain one or more nitrogen groups in their chemical structures. selected plant products containing alkaloids have been used as poison for hunting, murder and euthanasia, as euphoriants, psychedelics, stimulants and medicine. Basic nitrogen compounds from higher plants include many representatives that are potent inhibitors of various oxidative processes both in vivo and in vitro.

CHEMICAL CLASSIFICATION OF ALKALOIDS

Table.no.1

Class	Name	Biological properties	Plant family
True alkaloids	Atropine	Anticholinergic drug	Solanaceae
	Morphine	Narcotic and anaesthetic properties	Papaveraceae
Protoalkaloids	Mescaline	Hallucinogen	Cactaceae
	Ephedrine	Sympathetic nervous system	Ephedraceae
Pseudoalkaloids	Aconitine	Highly poisonous	Ranunculaceae
	Theobromine	Stimulating the central nervous system	Malvaceae

TEST:

Table no.2 Chemical test of Alkaloids.

	OBSERVATION	INTERFERENCE
Dragendorff test Sample solution+Dragendroffs reagent (solution of potassium bismuth iodide)	Formation of red precipitate	Presence of Alkaloids
Wagner's test Sample solution+ Iodine in Potassium iodide	A Brown reddish precipitate	Presence of Alkaloids
Mayer's test Sample solution +Potassium mercuric iodide	yellow-coloured precipitate was formed	Presence of Alkaloids
Hager's test Sample solution + Saturated picric acid solution	Yellow-coloured precipitate was formed	Presence of Alkaloids

❖ GLYCOSIDES

Glycosides are natural secondary metabolites in which a sugar part is joined to a non-sugar part by a special bond called a glycosidic bond. When these compounds are broken down, they release sugar and another substance that often has important biological or medicinal

effects. They are commonly found in plants and play a significant role in nature and medicine.

CLASSIFICATION:

Table.no.3: Classification of glycosides based on aglycone

Types of glycosides	Examples	Use/property
Anthraquinone	Senna, Aloe	Laxatives
Cardiac	Digitalis	Cardiotonic
Saponin	Liquorice	Foam forming
Cyanogenic	Bitter almond	Release HCN

Table.no.4: Classification of glycosides based on glycosidic linkage

Type	Linkage	Characteristics
O-glycosides	Through Oxygen	Most common
C-glycosides	C-C bond	Stable
N-glycosides	Through nitrogen	Found in nucleosides
S-glycosides	Through sulphur	Present in mustard

TEST:

Table.no.5: Chemical Test of Glycosides.

Chemical test		
Keller-Killani Test Mix the extract with glacial acetic acid containing ferric chloride+concentrated sulphuric acid carefully along the side of the test tube	A reddish-brown layer formed, which turns to bluish green colour due to presence of digitoxose.	Presence of Cardiac glycosides
Borntrager's Test Powder extract+dil. With HCL Add chloroform+shake well+ Add few drops ammonia, slightly shake, keep as side for few min. **Modified Borntrager's Test** Modified version, Add FeCl3.	A pink or red colour in the ammoniacal layer A pink or red colour in the ammoniacal layer	Presence of Anthraquinone glycosides{o-g}
Legals Test Sample+Pyridine Mix Na. nitroprusside+ add NaOH (make alkaline)	Pink to red coloration	Presence of Cardiac glycosides
Baljets Test Sample+ Sodium Picrate soln.	Orange coloration	Presence of Cardiac glycosides

❖ PHENOLIC COMPOUND

Phenolic compounds are a large and diverse group of plant secondary metabolites characterized by the presence of one or more aromatic rings bearing hydroxyl (–OH) groups. They are synthesized mainly through the phenylpropanoid pathway and include subclasses such as flavonoids, tannins, phenolic acids, and lignin. These compounds play essential roles in plants, including defence against pathogens and herbivores, protection against ultraviolet (UV) radiation, structural support (e.g., lignin in cell walls), and signalling. They are also known for strong antioxidant activity, contributing to human health by reducing oxidative stress.

TEST:

Table.no.6: Chemical Test of Phenols.

Chemical Test	Observation	Interference
Ferric chloride Test Sample few drops of neutral ferric chloride solution	A deep blue, green coloration.	Presence of phenolic compound.
Lead acetate Test Sample+lead acetate solution.	Formation of White precipitate.	Presence of Phenolic compound.
Bromine Water Test Sample+Bromine water.	Decolorize bromine water and form white precipitate.	Presence of Phenolic compound.

❖ TERPENES

Terpenes are natural compounds made by plants that give them their smell and flavor. they are built from isoprene units and help plants by protecting against insects and attracting pollinators. Terpenes are classified based on the number of isoprene units they contain, such as monoterpenes (2 units), sesquiterpenes (3 units), and diterpenes (4 units). They are also important because they have medicinal properties, such as anti-inflammatory and antimicrobial effects.

TEST:

Table.no.7: Chemical Test of Terpenes.

Chemical Test	Observation	Interference
Salkowski Test Sample dissolve in Chloroform, add concentrated Sulphuric acid along the side of the test tube.	Formation of red color in the ammonia layer, Greenish yellow fluorescence in the acid layer.	Presence of Terpenoids
Liberman-Burchard Test Sample+Acetic anhydride + Concentrated Sulphuric acid.	A blue/green coloration develops.	Presence of Terpenes

2.3 MECHANISM OF ACTION OF HERBAL MEDICINES

Many plants are known for their **toxic or hallucinogenic properties** because they produce **secondary metabolites (SM)** such as alkaloids and terpenoids. These compounds interact specifically with molecular targets in animals and humans.

The common molecular targets include:

- Neuroreceptors
- Enzymes that degrade neurotransmitters
- Ion channels
- Ion pumps
- Cytoskeletal elements like tubulin and microtubules

For example, compounds from Atropa belladonna affect cholinergic receptors, while alkaloids from Papaver somniferum act on opioid receptors. Similarly, compounds from Catharanthus roseus interact with tubulin and are used in cancer treatment.

Many of these secondary metabolites are now extracted and used in modern medicine as well-defined drugs. They show high specificity toward particular biological targets. [12]

It has been proposed that the shapes of these molecules were refined during evolution through a process called **"evolutionary molecular modeling."** This means that, through natural selection, plant chemicals gradually developed structures that perfectly fit biological targets—similar to how medicinal chemists design drugs using molecular modeling techniques.

Adaptogens are herbal substances that help the body maintain balance (homeostasis). They can either increase or decrease body functions depending on what the body needs. They work by affecting the immune system and endocrine (hormone) system.

After entering the body, their active compounds can enter cells and influence hormone production and nervous system signals. Many adaptogens contain polysaccharides or plant sterols (phytosterols). They also act as antioxidants, helping to protect the body from damage caused by free radicals. [13]

2.4 SYNERGISTIC EFFECT ON THE WHOLE PLANT FORMULATION [14]

The synergistic effect in herbal medicine occurs when two or more herbs or their active compounds interact together to produce a stronger therapeutic effect than when used individually.

In other words:

Combined effect > Sum of individual effects

This principle is widely used in traditional systems such as Ayurveda, Traditional Chinese Medicine, and modern Phytotherapy.

➢ **Mechanism of Herbal Synergy**

Herbal synergy occurs through several mechanisms:

1. **Pharmacokinetic synergy**
   - One herb improves **absorption, distribution, metabolism, or excretion** of another herb.
2. **Pharmacodynamic synergy**
   - Herbs act on **different biological targets but produce a common therapeutic effect**.
3. **Protective synergy**
   - One herb reduces the **toxicity or side effects** of another.
4. **Additive or potentiating effect**
   - Herbs enhance the **overall pharmacological activity**.

General Model of Herbal Synergistic Action

Herb A (Active compound A)
↓
Herb B (Active compound B)
↓
Biochemical interaction
↓
Enhanced pharmacological effect
↓
Improved therapeutic outcome

➢ **EXAMPLES OF SYNERGISTIC EFFECT**

a) TURMERIC (Curcuma longa)-BLACK PEPPER (Piper nigrum)

ACTIVE COMPOUND:

- Curcumin (from turmeric)
- Piperine (from black pepper)

Synergistic Mechanism:

➢ Curcumin alone has **poor bioavailability**.

➢ Piperine **inhibits liver enzymes and improves intestinal absorption**, increasing curcumin availability in the body.

Uses:

- Strong **anti-inflammatory activity**
- Enhanced **antioxidant activity**
- Improved **joint and digestive health**

Turmeric (Curcumin)
↓
Low absorption
↓
Black Pepper (Piperine)
↓
Enhanced absorption
↓
Stronger anti-inflammatory effect

Advantages of Herbal Synergy

1. Increased **therapeutic effectiveness**
2. Lower **dosage requirement**
3. Reduced **side effects**
4. Multi-target treatment of diseases
5. Improved **bioavailability**

Applications

Synergistic herbal combinations are used in treating:

- Inflammation
- Arthritis
- Digestive disorders
- Cardiovascular diseases
- Microbial infections [15]

MODULE III

ADVANCE NEUTRACEUTICALS: MOLECULAR MECHANISM AND CLINICAL RELEVANCE NEUTRACEUTICALS:

Nutraceuticals are natural substances taken from foods that provide health benefits beyond basic nutrition. They help in preventing diseases, improving body functions, and maintaining overall health. Unlike dietary supplements, which mainly add nutrients like vitamins and minerals, and pharmaceuticals, which are chemically made drugs used to treat specific diseases, nutraceuticals come from food and offer both nutritional and therapeutic benefits.

Nutraceuticals have been used for a long time in traditional systems like Ayurveda and Chinese medicine, where food and plants were used for healing. Today, modern science has helped us understand how these natural compounds actually work in the body.

Overall, nutraceuticals connect traditional natural healing with modern medicine and support a more balanced and preventive approach to healthcare. [16]

3.1 MECHANISM ACTION OF NUTRACEUTICAL

Nutraceuticals help improve health by working at different levels in the body—molecular, cellular, and systemic. They act in several ways, such as reducing oxidative stress (antioxidant effect), lowering inflammation, and regulating cell signalling, genes, gut microbiota, and metabolism. These actions help in disease prevention, management, and overall well-being.

- **Antioxidant Mechanisms**:

Nutraceuticals help fight oxidative stress linked to aging and chronic diseases like heart disease, neurodegeneration, and cancer. primary mechanisms for nutraceutical effects is their ability to scavenge free radicals and reactive oxygen species (ROS). Polyphenols, including resveratrol, quercetin, as well as vitamins C and E, directly neutralize free radicals and ROS that cause cellular and tissue oxidative damage. Secondarily, nutraceuticals contribute to improving the body's antioxidant defences. Nutraceuticals such as sulforaphane found in broccoli and curcumin, help to stimulate the expression and function of several antioxidant enzymes, such as glutathione, superoxide dismutase (SOD), catalase, and promote their activity. Antioxidant enzymes are important for conserving cellular redox status and protecting against oxidative damage. [17]

- **Anti-inflammatory Pathway**:

Nutraceuticals help control chronic inflammation seen in diseases like arthritis, heart disease, and diabetes. They act by regulating key inflammatory pathways such as NF-κB (nuclear factor-kappa B) and COX-2, and other inflammatory mediators. Like curcumin and omega fatty acids affect the activation of NF-κB, which is essential to the inflammation process, and also suppress COX-2 and pro-inflammatory cytokines.

- **Gut Microbiota Interactions:**

Nutraceuticals support gut health by improving the balance of gut microbiota. Prebiotics (like dietary fibre and polyphenols) feed good bacteria, by providing necessary nutrients. while

probiotics (like lactobacilli and bifidobacteria) provide beneficial microorganisms, and more balanced proportions of microorganism populations directly into the gut to support greater microbial balance, leading to substantial support of digestive health. They also influence the gut-brain axis, helping in digestion, immunity, and even mental health. [18]

❖ **Specific Examples of Nutraceuticals and Their Mechanisms**

Nutraceuticals composed of a variety of bioactive compounds each acting via different mechanisms of action. The example below shows how different nutraceuticals exert their beneficial effects.

➢ **Eg: Polyphenols (e.g., curcumin, resveratrol)**

They are plant compounds with strong health benefits. They act as antioxidants by neutralizing free radicals and reducing oxidative stress, protecting cells from damage, caused by free radicals and oxidative stress. They also reduce inflammation by blocking pathways like NF-κB and COX-2.

Fig.no.6: Curcumin (Turmeric)

Fig.no.7: Resveratrol

These actions help lower the risk of chronic diseases like arthritis, heart disease, and metabolic disorders, and support overall health.

➢ **Eg: Omega-3 fatty acids**

(From fish oil and flaxseed) help improve heart health by lowering triglycerides and increasing good cholesterol (HDL). They also reduce inflammation, helping in conditions like arthritis and bowel disorders.

Fig. no.8: Omega−3 fatty acid.

Regular intake supports heart health, reduces inflammation, and helps prevent chronic diseases. [19]

Eg: Probiotics and prebiotics

They are important for gut and overall health. Probiotics (like *Lactobacillus* and *Bifidobacterium*) add good bacteria, while prebiotics (like fibre and inulin) help these bacteria grow. Together, they improve digestion, nutrient absorption, and support immunity [20]

Fig. no. 9: Probiotic capsule.

3.2 ROLE OF NUTRACEUTICALS IN LIFE STYLE DISORDERS

NUTRACEUTICALS ON DISEASE PREVENTION

Nutraceuticals play an important role in preventing different disease onset and minimize complication of the disease. It provides protection against non-communicable diseases, delay ageing process, increases life expectancy and improves function of the body.

1. Cardio vascular diseases:

Nutraceuticals like flavonoids, flavones, flavonones, quercetin in onion, cruciferous vegetables, black berries, cherries, berries, apples and other antioxidant vitamins and minerals may reduce the risk of death from CVDs. They inhibit cyclooxygenase pathway and angiotensin converting enzyme (ACE) which is responsible for high blood pressure. They also prevent platelet aggregation and stickiness. [21]

Table.no.8: Nutraceuticals in cardio vascular diseases.

Nutraceutical	Biological Source	Chemical Constituents	Therapeutic Role
Garlic	*Allium sativum*, Liliaceae.	Allicin, alliin, diallyl sulphide, diallyl disulphide. Vitamins: C, B1, B6	Reduces blood pressure, lowers cholesterol, inhibits platelet aggregation
Colchicine	*Colchicum autumnale*, Liliaceae	Colchicine, Colchicoside	Anti-inflammatory; reduces cardiovascular inflammation

2. Cancer:

Nutraceutical rich bioactive dietary components have the ability to prevent cancer. Herbal nutraceuticals possess anti-mutagenic and anti-carcinogenic properties. Antioxidant activities of carotenoids, lycopene is effective for cancer. They are oxygen quencher and decreases oxidative stress. Nutraceutical controls DNA damaging factors in cells and prevents DNA transcription in tumors. [22]

Table.no. 9 Nutraceuticals in cancer.

Nutraceutical	Biological Source	Chemical Constituents	Therapeutic Role
Curcumin	*Curcuma longa*, Zingiberaceae	Curcumin, dimethoxy curcumin. Volatile oils: Turmerone, zingiberene	Reduces inflammation and oxidative stress. Inhibits cancer cell proliferation and metastasis
Tomato	*Solanum lycopersicum*, Solanaceae	Lycopene, Beta-carotene, Vitamin C, Flavonoids (e.g., quercetin)	Antioxidant activity, inhibits cell proliferation, reduces oxidative DNA damage

3. Diabetes:

Herbal dietary supplements containing nutraceuticals have proven to offer therapeutic benefit on type 2 diabetes. Soy isoflavones, omega 3 fatty acid lowers mortality and incidence of diabetes, promote insulin sensitivity, reduce glucose tolerance and bring blood sugar normal. Universal antioxidants like lipoic acid and catechins, the spices like fenugreek and cinnamon are used to treat diabetic neuropathy, nephropathy and retinopathy.

Table.no.10 Nutraceuticals in diabetes.

Nutraceutical	Biological Source	Chemical Constituents	Therapeutic Role
Cinnamon	*Cinnamomum verum*, Lauraceae	Cinnamaldehyde, Eugenol, Cinnamic acid, Essential oils	Regulate blood sugar level, improves insulin sensitivity
Neem	*Azadirachta Indica*, Meliaceae	Azadirachtin, Nimbin, Nimbi din, Flavonoids	Reduces blood glucose levels, management of diabetic neuropathy

7. Alzheimer's disease:

Alzheimer's disease is also known as senile dementia. Antioxidants appear to slow down the advancement of the disease. Nutraceuticals like beta carotene, lycopene, curcumin, lutein and lavandula exploit their antioxidant effects to combat oxidative stress induced neuronal damage. These compounds are able to delay the development of dementia. Several studies

indicate that supplementation of vitamins like folic acid and B12 reduces homocysteine levels which also avert disease progression. [23]

Table.no.11 Nutraceuticals in Alzheimer's disease

Nutraceutical	Biological Source	Chemical Constituents	Therapeutic Role
Ginkgo biloba	*Ginkgo biloba*, Ginkgoaceae	Flavonoids, terpenoids (ginkgolides, bilobalide)	Enhances cognitive function, neuroprotective, improves circulation
Vitamin D	Sunlight (synthesized in skin), fatty fish	Cholecalciferol (D3), Ergocalciferol (D2)	Modulates immune response, supports neurogenesis

3.3 NUTRACEUTICALS AVAILABLE IN THE MARKET AND ITS FORMULATION

❖ **Vitamin C Tablets**

Vitamin C is required for the biosynthesis of collagen, L-carnitine, and certain neurotransmitters. Vitamin C is also involved in protein metabolism. Collagen is an essential component of connective tissue, which plays a vital role in wound healing. Vitamin C is also an important physiological antioxidant and has been shown to regenerate other antioxidants within the body, including alpha-tocopherol (Vitamin E).

o **Benefits:**

Immune function, skin health, antioxidant that protects cells, collagen production and UV damage protection, prevention and treatment of colds and infections, reduction of blood pressure in individuals with hypertension, preliminary anti-cancer properties, improvement of mood.

Fig. no. 10: Vitamin C tablet.

❖ **Ashwagandha**

Ashwagandha is an herb used in Ayurvedic medicine. It is also known as Indian ginseng and winter cherry. This herb may help reduce stress and anxiety. It may improve athletic performance and increase muscle strength. Ashwagandha may improve cognitive function

and reduce symptoms of depression. It may increase testosterone levels and improve fertility in men. It may not be safe for pregnant people and people with pre-existing health conditions.

Fig. no. 11: Ashwagandha tablet.

- **Benefits:**

Stress relief and anxiety reduction, improved sleep, improve cognitive function (including memory and reaction time), athletic performance enhancement, increased muscle strength, improved heart health, anti-inflammatory properties, neuroprotection, anti-cancer properties, improved fertility.

❖ **Fish oil**

Omega-3 capsules are a concentrated source of omega-3 fatty acids, a type of healthy fat needed by your body. These capsules, often derived from fish oil, krill oil, or algae, are a convenient way to boost your intake of omega-3 fatty acids. Regularly eat fatty fish. They are popular for promoting heart health, joint health, brain function, and reducing inflammation.

- **Benefits:**

Reduces the risk of heart disease. Improves brain function and mental health. Supports eye health and vision. Supports foetal development and cognitive function. Reduces inflammation and improves symptoms of chronic diseases. Supports joint health and reduces arthritis symptoms. Improves skin health and reduces acne. Supports bone health and reduces the risk of osteoporosis. Improves sleep quality and duration. Supports immune system function.

Fig. ***no.12: Omega−3 fish oil.***

❖ **Vitamin E 400 IU**

Vitamin E is the collective name for a group of fat-soluble compounds that have specific antioxidant activities. The only form of vitamin E that is recognized to meet human requirements is alpha-tocopherol. The recommended intake for adults is 15 mg of alpha-tocopherol. Vitamin E is important for protecting the body's cells from damage. Vitamin E supplements are used in premature newborns and people who have trouble absorbing enough vitamin E from their diet.

Fig. no. 13: Vitamin E capsules.

- **Benefits:**

Immune function, cell signalling, regulation of gene expression, other metabolic processes.

❖ **Probiotic Capsule:**

Probiotics are food and health products that contribute live, beneficial microbes to the populations within your gut and elsewhere, in order to strengthen those communities. They are meant to prevent and treat dysbiosis—an imbalance or deficit of beneficial microbes in your microbiome.

- **Benefits:**

Supports gut health and digestion, boosts the immune system, improves mental health and mood, helps with lactose intolerance and IBS symptoms, supports women's health and urinary tract health, may help with weight management and inflammation. [24]

Fig.no.14: Probiotic capsules.

MODULE IV

4.1 Future Aspects of Nutraceuticals: [25]

1. Personalized Nutrition

Future nutraceuticals will move toward individual-based therapy. Using genetic profiling (nutrigenomics), products can be customized according to a person's metabolism, lifestyle, and disease risk. This improves efficacy, safety, and patient outcomes compared to the "one-size-fits-all" approach.

2. Integration of Advanced Technologies

- Technologies like Artificial Intelligence (AI), big data, and omics sciences (genomics, Predict disease risks
- Recommend targeted nutraceuticals
- Optimize dosage and combinations

This leads to precision healthcare and preventive medicine**.**

3. Stronger Clinical Evidence

- One major future direction is evidence-based nutraceuticals.
- More clinical trials and human studies will be conducted
- Scientific validation of safety and efficacy will improve
- Increased acceptance among doctors and healthcare systems
- This helps bridge the gap between nutraceuticals and pharmaceuticals.

4. Improved Bioavailability

Many nutraceuticals (like curcumin, omega-3 fatty acids) have poor absorption.

➢ Future research focuses on:

- Enhancing solubility
- Protecting active ingredients from degradation
- Increasing absorption in the body
- This ensures maximum therapeutic benefit from smaller doses.

5. Role in Chronic Disease Management

Nutraceuticals will play a major role in preventing and managing chronic diseases, such as:

- Diabetes
- Cardiovascular diseases
- Cancer prevention
- Neurodegenerative disorders (e.g., Alzheimer's)

They support long-term health maintenance and reduce healthcare burden.

7. Regulatory Improvements

Governments are working toward stricter regulations and quality control.

➢ Authorities like Food Safety and Standards Authority of India are implementing:

- Better labeling requirements
- Safety and efficacy checks
- Standardized guidelines
- This increases consumer trust and product reliability.

8. Growth of Functional Foods

There is rising demand for functional foods and beverages, such as:

- Probiotic yogurts
- Fortified cereals
- Antioxidant-rich drinks
- These products integrate nutraceuticals into daily diet, making health management easier and more accessible.

4.2 Challenges of Nutraceuticals [26]

Nutraceuticals, defined as food-derived products that provide health benefits beyond basic nutrition, have gained significant attention in disease prevention and health promotion. Despite their growing popularity, several scientific, regulatory, and commercial challenges limit their effectiveness and widespread acceptance.

1. Lack of Strong Scientific Evidence

One of the major challenges in the nutraceutical field is the absence of robust clinical evidence supporting their therapeutic claims. Many nutraceutical products are marketed based on traditional knowledge or preliminary studies rather than well-designed clinical trials. This lack of standardized scientific validation raises concerns about their efficacy and reliability in disease prevention and treatment.

2. Regulatory Issues and Weak Control

Unlike pharmaceutical drugs, nutraceuticals are often regulated as food products in many countries. This results in less stringent regulatory requirements for safety, efficacy, and quality. The absence of a globally harmonized regulatory framework leads to inconsistencies in product approval, labeling, and marketing practices, increasing the risk of misleading claims.

3. Quality and Standardization Problems

Maintaining consistent quality in nutraceutical products is challenging due to variations in raw materials, processing methods, and storage conditions. Natural sources can differ in composition depending on environmental factors such as climate and soil. Lack of standardization may lead to batch-to-batch variability, affecting product safety and therapeutic outcomes.

4. Poor Bioavailability

Many nutraceutical compounds, such as curcumin and omega-3 fatty acids, exhibit low bioavailability, meaning they are poorly absorbed, rapidly metabolized, or quickly eliminated from the body. This reduces their therapeutic effectiveness. Enhancing bioavailability through advanced delivery systems remains a major area of research.

5. Safety Concerns and Drug Interactions

Although nutraceuticals are generally considered safe due to their natural origin, they can still cause adverse effects or interact with conventional medications. Overconsumption, contamination, or improper usage may lead to toxicity. Additionally, insufficient safety data for long-term use poses a significant concern.

6. Misleading Marketing Claims

The nutraceutical market is highly competitive, and some manufacturers promote exaggerated or unsupported health claims to attract consumers. This not only misleads the public but also undermines trust in genuinely effective products. Lack of strict monitoring contributes to this issue.

4.3 SUMMARY

This practice school report focuses on Herbal Therapeutic Agents and Nutraceuticals as alternatives to synthetic medicines. It explains how herbal medicines from plants are widely used because they are natural, affordable, and usually cause fewer side effects. The report describes traditional systems of medicine like Ayurveda, Unani, Siddha, and Homeopathy, along with their principles and healing approaches.

It also discusses phytochemicals such as alkaloids, glycosides, phenols, and terpenes, which are responsible for the medicinal actions of plants. It explains how herbal medicines work in the body through anti-inflammatory, antioxidant, antimicrobial, and immune-boosting effects. The concept of synergistic action is highlighted, where combinations like turmeric and black pepper produce stronger therapeutic effects together

Another major topic is nutraceuticals, which are food-derived substances that provide health benefits beyond nutrition. Examples include curcumin, omega-3 fatty acids, probiotics, vitamin C, and Ashwagandha. These nutraceuticals help in preventing diseases such as cardiovascular disorders, diabetes, cancer, and Alzheimer's disease by reducing oxidative stress and inflammation and improving gut health.

Finally, the report explains the future scope and challenges of nutraceuticals. Personalized nutrition, AI-based healthcare, improved bioavailability, and functional foods are considered future trends. However, issues like lack of strong scientific evidence, poor standardization, low bioavailability, misleading claims, and safety concerns remain major challenges. Overall, the report concludes that herbal therapeutics and nutraceuticals have significant potential in modern healthcare when supported by proper research and regulation.

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