Review Article

THE CONSERVATION OF MEDICINAL PLANTS IN NIGERIA

ABSTRACT

The relevance of medicinal plant as herbal medicine in sustained human health may not be neglected. These plants have healing/therapeutic effects in one or any of their organs. The use of these plants is rapidly expanding. They are used to maintain and improve human health in a variety of situations. In sustainable human health management, medicinal plants have played a significant role which has led to the growing interest in alternative therapies and therapeutic usage of plants. This is due to the fact that it is far less expensive than industrially produced synthetic forms of treatment. The majority of medicinal plant use occurs in Nigeria's rural areas, where there is easy access to a wide variety of plants on vast tracts of land with little to no urbanization. However, due to unchecked wild collecting and human interference, the majority of these plants are in danger of extinction. Therefore, it is advised that intentional efforts be directed toward domestication and cultivation in order to provide a steady supply of these plant species. This seminar study discusses the value and use of certain plants in medicine, endangered species, and conservation tactics.

KEY WORDS:

CONSERVATION, MEDICINAL, PLANTS, NIGERIA.

INTRODUCTION

For thousands of years, local people all over the world have used medicinal herbs as a means of healing. This is because a significant portion of the population (48%) in Nigeria lives below the international poverty threshold, and government health care services are insufficient and unequally distributed (Kankara*et al*., 2015; World Poverty Clock, 2020). Although 85% of the world's population still receives their primary healthcare from them (Pesic, 2015), they are also a valuable resource for drug development, as 80% of all synthetic pharmaceuticals are derived from them (Bauer and Bronstrup, 2014).

Both traditional and modern medicine can benefit from the use of medicinal plants. Approximately 80% of the rural population relies on these plants as their primary source of healthcare due to their demonstrated actual utility (Akinyemi, 2000). Since

ancient times, people from various continents—especially Africa—have utilized plants as sources of cures to heal a variety of illnesses. More than 25% of prescribed medications in developed nations are derived either directly or indirectly from plants, despite the twentieth century's notable advancements in synthetic organic medicinal goods (Newman *et al*., 2000). Nigeria has a wealth of native plants that are utilized in herbal therapy to treat wounds and illnesses (Okwu, 2007; Dike and Obembe, 2012).

A few of these plants have culinary or medicinal uses. Numerous biological and pharmacological properties, including anti-inflammatory, anti-cancer, diuretic, laxative, antispasmodic, anti-hypersensitive, anti-diabetic, and antimicrobial properties, are displayed by these plants. Phytochemicals, vitamins, and minerals are widely thought to be the active medicinal ingredients responsible for these protective benefits (Okwu and Ekeke, 2003; Okwu, 2004). Herbal medications are made in Nigeria using medicinal plants. According to Mafimisebi*et al*. (2013), herbal medicine, also known as botanical medicine, is the utilization of herbs to create products that are more recently and commonly recognized as herbal medical goods used for therapeutic or medicinal purposes.

According to Marshall (2011), Amujoyegbe*et al*. (2012), and Karki (2015), medicinal plants play a vital role in rural lives and are socioeconomically significant to the rural populace as a source of income and raw materials for medical cures (Elekwa*et al*., 2017).
Traditional medicine has been used for thousands of years to treat a wide range of illnesses in both developed and developing nations, and its significance has undoubtedly been generally recognized (Idu and Onyibe, 2007; Chukwuma *et al*., 2015). From ancient times to the present, medicinal plants have been valuable assets for human health (Dike and Obembe, 2012; Mahomoodally, 2013; Thillaivanan and Samraj, 2014).

In addition to treating skin conditions (Egharevba and Ikhatua, 2008), medicinal plants can be used as medications, foods, or ingredients for pharmaceutical preparations (Mamedov, 2012, Orji *et al*., 2013). They can also be used to treat obstetric and gynecological conditions, including birth control and family planning, pregnancy and childbirth complications, and other issues related to infertility (Aiyelaja*et al*., 2010; Kankara*et al*., 2015; Saalu, 2016).
Since prehistoric times, people on every continent have utilized hundreds to thousands of native plants to heal illnesses (Foladun and Imieje, 2013; Monier and El-Ghani, 2016; Elekwa*et al*., 2017).

According to Lubbe and Verpoorte (2011), plants are the source of specialty materials such biocides, colorants, medicines, and essential oils. Many medicines have been developed from the expertise of people who live in tropical forests, and it is obvious that more will be developed in the future (Monier and El-Ghani, 2016).
Oladele *et al*. (2011) also noted that younger generations' interest in learning

indigenous knowledge and skills in using plant resources for health care delivery is declining, and that the difficulties of rural-urban migration in pursuit of social infrastructures clearly poses a threat to the practice of traditional medicine in the future.

According to Dike and Obembe (2012), conservation efforts aimed at animals have long eclipsed those aimed at plants. Additionally, efforts to conserve plants have been dispersed among various production sectors that depend on plant resources, forestry, agriculture, non-wood forest products, and ecosystem types. According to Erinoso and Aworinde (2018), ethnobotany research is rather scarce in Nigeria because the field received little to no attention until recently. This is also partially linked to a dearth of knowledge in the subject and little to no financing for ethnobotanical research (Erinoso and Aworinde, 2018).
Traditionally, the majority of therapeutic plants are collected from their natural habitat in the wild.

However, medicinal plants face the grave threat of extinction due to numerous detrimental human and environmental factors, including overharvesting, deforestation, desertification, and global warming, to name a few. According to reports, overharvesting, habitat destruction, and big enterprises worldwide are putting some 15,000 species of medicinal plants in danger of going extinct (Naguib, 2011). Despite the growing interest in molecular modeling, combinatorial chemistry, and other synthetic chemistry techniques by pharmaceutical companies and R&D organizations, natural products—particularly medicinal plants—continue to be the source of new chemical entities and drug leads (Newman *et al*., 2000; Butler, 2004).

Scientific studies that aim to comprehend the active chemistry of the plants validate the therapeutic benefits of herbal medicine (Dawang*et al*., 2016). A plant's diverse chemical makeup accounts for its therapeutic effectiveness, with various plant sections having distinct medicinal benefits. The many medicinal effects of plants are caused by chemical components called phytochemicals, which include phenols, alkaloids, glycosides, tannins, acids, coumarins, sterols, and others. These compounds have served as models for or the original source of many contemporary medications. For instance, aspirin is made from salicylic acid, which is extracted from the bark of Salix alba and the meadowsweet plant, *Filipendula ulmaria*.

Antimalarial medications include artemisinin from the *Artemisia annua* plant and quinine from the bark of Cinchona pubescens. The Madagascar periwinkle, Catharanthus roseus, is the source of the anticancer medications vincristine and vinblastine, which are used to treat leukemia. While digitoxin is a cardiac glycoside derived from the foxglove plant, *Digitalis purpurea*, morphine and codeine, which are derived from the *Opium poppy*, *Papaver somniferum*, are used to cure diarrhea and relieve pain (Oreagba*et al*., 2011). Another significant source of resources for the cosmetics industry is medicinal

plants. Table 1 lists a few Nigerian medicinal plant examples along with their applications.

Table 1:Some selected Nigerian medicinal plants and their uses.

Family	Specie	Local name	Part used	Medicinal uses
Acanthaceae	*Acanthus montanus*		Stem, twig	Syphilis, cough, emetic, vaginal discharge
Amaranthaceae	*Amaranthus spinosus*		Whole plant	Abdominal pain, ulcers, gonorrhea
Apocynaceae	*Alstoniaboonei*		Root, bark, leaves	Breast development, filarial worms
Bombacaceae	*Adansonia digitata*		leaves, fruit, pulp, bark	Fever, antimicrobial, kidney, and bladder disease
Combretaceae	*Combretum grandiflorum*	Ikedike	leaves	Jaundice
Euphorbiaceae	*Brideliaferruginea*	iri, kirni	leaves, stem, bark, root	insomnia, mouth wash, gonorrhea
Hypericaceae	*Harungana madagascariensis*	Otoro, alilibarrafi	Stem, bark, root bark	piles, trypanosomiasis
Fabaceae	*AfzeliaAfricana*	Apa-igbo, akpalata	leaves, stem, bark, root	gonorrhea, hernia
Liliaceae	*Gloriosa superba*	mora, ewe aje, baurere	tubers, leaves	gonorrhea, headlice, antipyretic

Source: Abd El-Ghani (2016)

Table 1 shows families of some selected Nigerian medicinal plants with their common names, parts used and their medicinal uses.

Herbal Medicine

As synthetic chemistry emerged around the end of the 19th century, the usage of herbal medications decreased. However, as synthetic pharmaceuticals grew less successful due to high levels of resistance as well as increasing toxicity and cost, there was a renewed interest in plant medicines in more recent years. Plants are thought to be the source of almost half of all synthetic medications currently in use (Kamsu-Foguem andFoguem, 2014).
Herbal medicine is a unique and well-known type of traditional medicine where the herbalist, or traditional healer, specializes in using plants to cure a variety of illnesses.

Their function is particularly noteworthy because it stems from a deep understanding of the therapeutic qualities of native plants and the pharmaceutical processes required to transform them into medications, including selection, compounding, dose, efficacy, and toxicity. Across societies, the usage of herbal remedies seems to be universal. The plants used to cure the same conditions and the methods of treatment, however, may differ depending on the location. Generally speaking, medicinal plants are any plants that have substances in one or more of their organs or parts that can be used for therapeutic purposes; in a more contemporary sense, the constituents can be used as building blocks for the synthesis of drugs.

For instance, certain herbs have long been utilized in traditional medicine without supporting scientific evidence. Here, the term "crude drugs of natural or biological origin" refers to the entire or parts of these plants that have therapeutic qualities. If the drugs come from cellular plant parts like leaves, bark, roots, etc., they may also be categorized as "organized drugs." If they come from acellular plant parts such gums, balsams, gels, oils, and exudates, they may be categorized as "unorganized drugs." In contrast to contemporary allopathic medicine, herbal medicine is widely accessible and freely available (Tabuti, 2006; Anoka, 2012).

As a result, traditional healers are rarely consulted because people, particularly in rural regions, have a reasonable understanding of common medicinal herbs, with the exception of treating chronic illnesses (Tabuti, 2006). There is inconsistency among traditional healers on the proper dosage and preparation methods of herbal medicines, even in cases where consultation is conducted (Wilcox and Bodeker, 2004). Nonetheless, at least 80% of Africans still receive their medical care from medicinal plants, according to WHO (2002–2005). Herbal medicine has continued to gain popularity in Nigeria and throughout West Africa due to its many benefits, including its low cost, affordability, availability, acceptability, and perceived low toxicity (Parmer, 2005).

A detail of plant parts used in herbal medicines is as follows:

- Roots—i.e., the fleshy or woody roots of many African plant species are medicinal. Most of the active ingredients are usually sequestered in the root bark rather than the woody inner part.
- Bulbs—A bulb is an underground structure made up of numerous leaves of fleshy scales, e.g., *Allium sativa* (garlic) and *Allium cepa* (onions).
- Rhizomes—Woody or fleshy underground stem that grows horizontally and brings out their leaves above the ground, e.g., *Zingiber officinale* (ginger), which is used for respiratory problems; *Imperata cylindrica* (spear grass) for potency in men and *Curcuma longa* (turmeric), an antioxidant, anti-inflammatory, and anticancer drug.
- Tubers—Swollen fleshy underground structures which form from stems/roots, e.g., potatoes and yams such as *Dioscorea dumetorum*(ona-(igbo)) for diabetes and *Gloriosa superba* for cancer.
- Bark—The outer protective layer of the tree stem or trunk. It contains highly concentrated phytochemicals with profound medicinal properties. A host of plants have barks of high medicinal value.
- Leaves, stems, and flowers of many plants are also medicinal.
- Fruits and seeds also contain highly active phytochemicals and essential oils.
- Gums, exudates, and nectars, which are secreted by plants to deter insects and grazing animals and to seal off wounds, are very useful in the pharmaceutical industries.
- Sale of herbs in form of dried or fresh plant parts is as lucrative as the prepared medicines. They are usually displayed in markets and sold with instructions on how to prepare them for maximum efficacy.

Methods of preparation and dosage forms

Methods of preparation of herbal medicines may vary according to place and culture. The plant materials may be used fresh or dry. With experience, a particular method is chosen to increase efficiency and decrease toxicity. Generally, different methods of preparation include:

- Extraction—This is prepared with solvent on a weight by volume basis. Sometimes, the solvent is evaporated to a soft mass.
- Infusions are prepared by macerating the crude drug for a short period of time in cold or hot water. A preservative such as honey may be added to prevent spoilage.

- Decoctions are made by boiling woody pieces for a specified period of time and filtered. Potash may be added to aid extraction and as preservative.
- Tinctures are alcoholic infusions which if concentrated may be diluted before administration.
- Ashing—The dried parts are incinerated to ash, then sieved and added as such to water or food.

- Miscellaneous—Additional varieties include lotions, which are liquid preparations used for skin application, and liniments for external applications in liquid, semi-liquid, or greasy forms containing the active ingredients. Fresh plant parts that have been macerated and contain plant juice are used to make poultices, which are then applied to the skin. Snuff is a dried plant powder that is inhaled through the nose. It is possible to burn dried plants and use the resulting charcoal. Gruels are grain-based cereals or porridges to which dried plant powder or ash is added for oral consumption. In order to provide synergistic or potentiating effects of the composite plants, mixtures of many plants are occasionally produced.

  Additionally, there are several administration techniques. In addition to the standard routes—oral, rectal, topical, and nasal—other techniques include passive inhalation or smoking a shabby cigar made with dried plant components. Others are breathing the volatile oils that are evaporating from the boiling plant matter while steaming. These can be used to treat respiratory issues, headaches, and congestion. ASICUMPON (2005) and Okafor (2013) discuss the use of Sitz baths for piles.

Traditional African medicine and its relationship with modern medicine

Historically, plants have provided most of the world's medicines, and they continue to provide humans with new means of self-healing. Natural substances or their derivatives make up more than 50% of all medications used in clinical settings, with higher plants making up more than 25% of this total. Modern medicine makes use of a variety of African botanicals. Thanks to scientific breakthroughs, these plants, which have long been used in traditional medicine, are today the source of important pharmaceuticals. Here are some examples of these drugs along with their origins:

Ajmalicine for the treatment of circulatory disorders and reserpine for high blood pressure and mental illness both from *Rauvolfiaserpentina*, L-Dopa for parkinsonism is obtained from *Mucuna* species, vinblastine and vincristine used for the treatment of leukemia from *Catharanthusroseus*, physostigmine from *Physostigmavenenosum*, or “Calabar bean,” used as a cholinesterase inhibitor, strychnine from the arrow poison obtained from the plant Strychnos nux-vomica, atropine and hyoscine from Atropa belladonna leaves. A host of other African plants with promising pharmaceutical potentials include Garcinia kola, *Aframomummelegueta*, *Xylopiaaethiopica*, *Nauclealatifolia*, *Sutherlandiafrutescens*, *Hypoxishemerocallidea* (African wild potato),

and *Chasmantheradependens* as potential sources of anti-infective agents, including HIV, with proven activities (Street and Prinsloo, 2013),while *Cajanus cajan, Balanites aegyptiaca, Acanthospermumhispidum, Calotropis procera,Calotropis procera*, *Jatropha curcas*, among others, as potential sources of anticancer agents (Mbele*et al.,* 2017).

NIGERIAN MEDICINAL PLANTS AND THEIR USES

Azadirachta indica (neem)

"Dogonyaro," "darbejiya," "igi-oba," and "ogwu-akom" are the native names for neem in Nigerian Hausa, Yoruba, and Igbo, respectively. Common throughout the country's northeast, northwest, and central geopolitical zones, neem trees serve as shelter belts to prevent desertification. As early as 1830, De Jussieu identified the neem tree as A. indica, and its taxonomic status is as follows:

- Order Rutales
- Suborder Rutinae
- Family Meliaceae (mahogany family)
- Subfamily Melioideae
- Tribe Melieae
- Genus *Azadirachta*
- Species *indica*

Azadirachta indica is a very useful traditional medicinal plant in the African sub-continent. Each part of the tree has some medicinal properties which can be used to treat several diseases (Shahed *et al.,* 2011; Velusamy *et al.,* 2015).

Therapeutic and medicinal effects of *Azadirachta indica*

Azadirachta indica has a wide range of medicinal applications. Surprisingly, its bark and leaves were used to treat boils, ulcers, enlarged spleen, smallpox, measles, head scald, and malarial fever during childbirth (IUCN, 2020). Additionally, a number of diseases, including those brought on by Plasmodium and Mycobacterium, could be cured by neem seed oil as well as the essential oils of leaves and bark (Nagesh VSDNA *et al*., 2017). Because nimbin and nimbinin were discovered, neem oil was used as a mosquito repellant and a contraceptive (for vaginal infections) (IUCN, 2010). The following are additional medical effects:

Antioxidant effect

Since they destroy many biological molecules by removing electrons to reach a stable state, free radicals, also known as reactive oxygen species (ROS), are a primary cause of inflammation. This causes oxidative stress in the cell (Alzohairy, 2016, Kiranmai *et al*., 2011). Therefore, in order to prevent or block an escalation of oxidative stress, which can result in a number of diseases, it is necessary to provide sufficient chemicals (referred to as antioxidants) to stabilize or neutralize free radicals. The body's natural antioxidant defenses, which include nitric oxide dioxygenase (NOD), glutathione peroxidase (GPX), glutathione (GSH), catalase (CAT), and superoxide dismutase (SOD), will be strengthened by these antioxidant molecules (Basir and Shailey, 2012; Gautam *et al*., 2015).

One simple way to provide the body these nutrients is to supplement the diet. Supplementing with natural extracts, such as those from Neem, appears to be an easy and affordable way to introduce antioxidants (Alzohairy, 2016; Farjana *et al*., 2014; Khamis Al-Jadidi and Hossain, 2015; Page and Hawes, 2013; Yerima *et al*., 2012). While there is ongoing debate and research regarding the safety and efficacy of extracts, we can still consider some preparations, such as those commonly used in medicinal folklore, as safe, even though their potential benefits vary depending on the preparation.

Given this, we shouldn't rule out the idea that certain natural compounds could further alter particular medical problems.
Numerous studies on Neem have been published over time with the aim of assessing its antioxidant qualities and/or bolstering the body's defenses. One such study extracts possible chemicals from Neem using methanol and leaves. In this work, they used a model of induced intestinal ischemic-reperfusion damage (IIRI) to test this extract on rats as a pre-treatment for seven days at a dose of 100–200 mg/kg. They compared this extract to untreated and vitamin C-treated animals, which is known to be an antioxidant. The extract group decreased a number of inflammatory markers, including myeloperoxidase in the serum, while IIRI rats decreased the expression of extracellular regulated kinase (ERK1/2).

Similarly, nitric oxide levels decreased for IIRI (0.025 µmole/l) but remained constant for non-IIRI (control 0.036 µmole/l, extract 0.034 µmole/l, and vitamin C 0.042 µmole/l). We concluded that the extract helps strengthen the body's natural defenses because the extract group also boosted GSH levels, which led to the recovery of glucose-6-phosphate dehydrogenase (G6PD) (Omóbòwálé*et al*., 2016).

Anti-inflammatory effect

Neem extracts' capacity to function as anti-inflammatory agents is a significant characteristic (Rupani and Chavez, 2018; Soares *et al*., 2014). Numerous illnesses,

including diabetes and cancer, as well as other conditions like alcohol use and food digestion, are influenced by inflammation, a pathophysiological state (Eldeen *et al*., 2016). Nowadays, limonoid is one of the primary bioactive substances in neem. Limonoid is a furanolactone that is well-known for its ability to decrease the synthesis of inflammatory mediators. Because it promotes the activation of endogenous opioid pathways, it is sometimes referred to as a pain anesthetizer (Naik *et al*., 2014, Schumacher *et al*., 2011, Soares *et al*., 2014).

Soares et al. showed that limonoid produced from Neem can decrease fibrovascular tissue development and edema when tested on wounded rat paws. They discovered that the most advantageous dosage was 120 mg/kg, which showed a particular inhibitory effect over significant inflammatory molecules such as tumor necrosis factor alpha (TNF-α) and interleukins (Soares *et al*., 2014). Over time, several studies have investigated and validated the mechanism of limonoids' anti-inflammatory effect (Chen *et al*., 2018; Kumar *et al*., 2010; Tapanelli*et al*., 2016; Zhu *et al*., 2017). Interestingly, a substantial amount of evidence suggests a fascinating relationship between anti-inflammatory qualities and anti-cancer medications; this is discussed in more detail elsewhere in this paper.

Anti-cancerous effect

Over the past few decades, studies have been carried out to determine the anti-cancer potential of phytochemicals and medicinal plants, which are typically contained in the diet (Sengupta *et al*., 2017). The primary component that is usually looked at is their ability to interfere with several pathways that control growth, apoptosis, and even chemotherapy protection (Zhang *et al*., 2015). In one study, Pramanik *et al*. (2016) used hamster buccal carcinogenesis models to investigate the chemoprotective qualities of neem compounds, including azadirachtin, nimbolide, and limonoid concentrate extracts. They demonstrated the positive benefits of neem extracts, which include blocking the NF-κβ pathway.

Anti-diabetic effect

One of the most common chronic degenerative diseases is diabetes, or the inability to regulate blood glucose levels (Hieronymus and Griffin, 2015). Lower-cost treatments are required as the disease worsens and becomes a lifelong physical and financial burden on the patient. The application of neem extracts has gradually gained popularity among the several techniques and pharmacotherapies being explored (Al Akeel *et al*., 2017).
In a nutshell, diabetes comes in two varieties. Studies on the impact of neem extracts on both forms of diabetes have produced conflicting findings. As neem extracts are still being studied for their effects and toxicity, we advise against using them directly.

Type I diabetes, which is known to start early, is caused by the pancreatic β-cell's incapacity to produce insulin (Shiuchi*et al*., 2002). Diabetes type II, which occurs in genetically predisposed people who lead sedentary lives and consume excessive quantities of calories, is mostly caused by insulin resistance, which affects how well muscle and fat cells absorb glucose. Here, the synthesis of NAPDH is inhibited by a reduction in glucose-6-phosphate dehydrogenase (G6PD). Reactive oxygen species (ROS) are produced in excess and the antioxidant system's effectiveness is diminished with time as a result of intracellular NAPDH depletion (Abdel-Moneim *et al*., 2014).

The overall process disruption introduces a state of oxidative stress, which induces proinflammatory signaling molecules such as TNF-α and IL-6 (Alam *et al*., 2012). The conclusion of said mechanism is the activation of the insulin resistance pathways, leading to an ultimate diabetic state (Gautam *et al*., 2015).

Hepatoprotective effect

The hepatoprotective properties of medicinal plants and their constituents are essential and come with no negative side effects. Histology and ultrastructure results verified that pretreatment with azadirachtin-A dose-dependently decreased hepatocellular necrosis in a study to examine the hepatoprotective role of azadirachtin-A in carbon tetrachloride (CCl4)-induced hepatotoxicity in rats (Baligar*et al*., 2014). Additionally, the study's findings indicate that azadirachtin-A pretreatment at higher dose levels somewhat returns the rat liver to normal (Baligar*et al*., 2014).

Wound healing effect

Wound healing is significantly impacted by a variety of plants and their constituents. In one study, the wound healing ability of extracts of *A. indica* and *T. cordifolia* leaves was evaluated using excision and incision wound models in Sprague Dawley rats. The results shown that in both excision and incision wound models, the extracts of both plants markedly enhanced the wound healing activity (Barua*et al*., 2010). Additionally, it was discovered that the tensile strength of the healing tissue in incision wounds was significantly stronger in both plant-treated groups than in the control group (Ofusori*et al*., 2010). According to other findings, *Azadirachta indica* leaf extracts enhance wound healing activity by promoting neovascularization and an inflammatory response (Osunwoke*et al*., 2023).

Anti-microbial Effect

Neem and its ingredients play role in the inhibition of growth of numerous microbes such as viruses, bacteria and pathogenic fungi. The role of neem in the prevention of microbial growth is described individually as follows;

ANTIBACTERIAL ACTIVITY

- A study was carried out to evaluate the antibacterial efficiency of herbal alternatives as endodontic irrigants in comparison to the traditional irrigant sodium hypochlorite. The findings verified that extracts from grape seeds and leaves showed zones of inhibition, suggesting that they have antibacterial properties (Ghonmode*et al*., 2013). Furthermore, leaf extracts showed notably greater zones of inhibition in comparison to 3% sodium hypochlorite (Ghonmode*et al*., 2013).
  The results of the study showed that guava and neem extracts contain antibacterial components that could help prevent spoilage organisms and foodborne diseases. The antibacterial activity of the extracts was evaluated against 21 foodborne pathogen strains (Mahfuzul*et al*., 2007).
- The bark and leaf extracts of *Azadirachta indica* (neem) demonstrated antibacterial activity against all test bacteria used in an additional experiment to assess the antibacterial activity of these materials on bacteria isolated from adult mouths (Yerima *et al*., 2012). Additionally, only at higher doses did seed and fruit extracts exhibit antibacterial action (Yerima *et al*., 2012).

ANTIVIRAL ACTIVITY

According to the results, at concentrations between 50 and 100 µg/mL, neem bark (NBE) extract effectively inhibited HSV-1 entrance into cells (Yerima, 2012). Additionally, when the extract was preincubated with the virus but not with the target cells, inhibiting activity of NBE was seen, indicating a direct anti-HSV-1 capability of the neem bark (Tiwari *et al*., 2010).

ANTIFUNGAL ACTIVITY

- The effectiveness of several neem leaf extracts on the seed-borne fungus Aspergillus and its Rhizopus was tested in an experiment. The findings showed that both alcoholic and water extracts greatly reduced and controlled the growth of both fungal species. Additionally, neem leaf alcoholic extract was more successful than aqueous extract at delaying the growth of both fungal species (Mondali*et al*., 2009).
  Another finding showed the antimicrobial role of aqueous extracts of neem cake in the inhibition of spore germination against three sporulating fungi such as *C. lunata, H. pennisetti*, and *C. gloeosporioides* f. sp. mangiferae (Anjali *et al*., 2013) and results of the study revealed that methanol and ethanol extract of *Azadirachta indica* showed growth inhibition against *Aspergillus flavus*, *Alternaria solani,* and *Cladosporium* (Shrivastava and Swarnkar, 2014).

A study was undertaken to examine the antifungal activity of *Azadirachta indica* L. against *Alternaria solani*Sorauer and results confirmed that ethyl acetate fraction was found most effective in retarding fungal growth with MIC of 0.19mg and this fraction was also effective than fungicide (metalaxyl + mancozeb) as the fungicide has MIC of 0.78mg (Jabeen *et al.,* 2013).

ANTIMALARIAL ACTIVITY

- Plasmodium berghei-infected albino mice were used in an experiment to test the antimalarial activity of extracts. The results showed that neem leaf and stem bark extracts decreased parasitemia levels in infected mice by roughly 51–80% and 56–87%, respectively (Akin-Osanaiya*et al*., 2013). Other studies demonstrated that azadirachtin and other limonoids found in neem extracts are effective against malaria vectors (Nathan *et al*., 2005).
- The activity against the sexual and asexual forms of the malaria parasite Plasmodium falciparum was also assessed in vitro using crude acetone/water (50/50) extract of leaves (IRAB). The results demonstrated that, in separate 72-hour cultures of mature gametocytes and asexual parasites treated with IRAB (0.5 microg/mL), the parasite numbers were less than 50% of the numbers in control cultures, which had 8.0% and 8.5% parasitemia, respectively (Udeinya*et al*., 2008).

Other therapeutic effects of neem plant includes;

- Antinephrotoxicity Effect
- Neuroprotective Effects
- Immunomodulatory and Growth Promoting Effect

Other medicinal uses of various parts of neem plant are shown in Table 2.

Table 2 : Medicinal uses of various parts of neem plant.

Part	Medicinal use
Leaf	Leprosy, eye problem, epistaxis, intestinal worms, anorexia, biliousness, skin ulcers.
Bark	Analgesic, alternative and curative of fever.
Flower	Bile suppression, elimination of intestinal worms and phlegm.
Fruit	Relieves piles, intestinal worms, urinary disorder, epistaxis, phlegm, eye problem, diabetes, wounds and leprosy.
Twig	Relieves cough, asthma, piles, phantom tumour, intestinal worms, spermatorrhea, obstinate urinary disorder, diabetes.
Gum	Effective against skin diseases like ring worms, scabies, wounds and ulcers.

Seed pulp	Leprosy and intestinal worms.
Oil	Leprosy and intestinal worms.
Root, bark, leaf, flower, and fruit together.	Blood morbidity, biliary afflictions, itching, skin ulcer, burning sensation and leprosy.

Source: Kausik *et al.,* (2002).

Acacia nilotica (Thorn mimosa or gum Arabic tree)

Acacia nilotica, commonly called Acacia, Egyptian mimosa, gum Arabic tree or Thorn mimosa, DesiKikar is a deciduous tree plant found growing mostly in the Sahel region of Africa including Northern Nigeria. It is locally called “bagaruwa” in Hausa. Its taxonomic position according to Linnaeus is as follows;

- Order Fabales
- Family Fabaceae
- Genus *Acacia*
- Species *nilotica*

In Nigeria, *A. nilotica* was found to be used as urban forestry species (Ajewole O *et al.,* 2010). Many studies reported that *Acacia nilotica* is a great source of many active secondary metabolites, which may serve as potential candidates for drug business in future (Raj and Chandrawanshi, 2015).

Medicinal Activities of *Acacia nilotica*

Antimicrobial activity

Numerous studies have shown that acacia extracts and some of the chemicals extracted from them have the capacity to eradicate bacteria, viruses, and parasites, making *A. nilotica* one of the plants rich in antimicrobial compounds (Ratherand Mohammad, 2015). Using the agar diffusion method, the investigations verified that the acacia bark extract was efficient against *Shigella sonnei*, *Escherichia coli*, *Bacillus subtilis*, *Streptococcus viridans*, and *Staphylococcus aureus* (Banso, 2009). In a later study, researchers also showed that the Acacia plant is efficient against two kinds of fungi (*Candida albicans* and *Aspergillus niger*) and three species of bacteria (*Salmonella typhi*, *Staphylococcus aureus*, and *Escherichia coli*) (Kalaivani and Matthew, 2010).

The 10% methanolic extract of the pods of the Acacia plant shown bactericidal action against methicillin-resistant *Staphylococcus aureus*, *Klebsiella* species, and *Escherichiacoli* (Riaz *et al*., 2011). Acacia fruit extract was found to have antibacterial activity against the majority of the bacteria tested in a study that compared its antibacterial activity to clinical isolates of several Gram-positive (*Bacillus cereus* and *Listeriamonocytogenes*) and Gram-negative (*Klebsiella pneumonia, Escherichia coli, Salmonella typhi, Shigella flexneri,* and *Pseudomonas aeruginosa*) bacteria. The diameter of the inhibitory zone against *Salmonella typhi* and *Bacillus cereus* was larger than that of the well-known antibiotic gentamicin (Gmaraldeen*et al*., 2016).

Another in vitro study evaluated the effect of a hot ethanolic extract of Acacia fruits and seeds on the ongoing development of various bacterial species using the agar well

diffusion method. The results showed that at a concentration of 100 mg/ml, Proteus mirabilis, Staphylococcus aureus, and Streptococcus pneumonia were all inhibited from developing. In contrast, Pseudomonas aeruginosa and Escherichia coli were both eradicated at a dosage of 75 mg/ml (Hameed *et al*., 2017).
Ninety human volunteers who were most exposed to tooth decay participated in the study by Gupta and Gupta (2015).

They studied the use of ten ml of 50% Acacia mouthwash twice a day compared with the effect of ten ml standard mouth wash chlorhexidine 0.2% on the growth of oral *Streptococcus* mutans (anaerobic, gram-positive coccus).

Antiparasitic activity

Acacia root extract was shown by Jigam*et al*. (2010) to be effective against *Plasmodium falciparum* and *Plasmodium berghei* in mice. A study that looked at the antimalarial effect of Acacia root extract (eluted fractions, 50 and 100 g/kg) found that the *Plasmodium berghei* count in the infected mice considerably decreased. Furthermore, the extract improved the sick mice's survival age and reduced the hemoglobin deficiency in the treated mice (Alli *et al*., 2016).
Acacia leaf, pod, and stem bark extracts were shown to have antimalarial properties in a 48-hour schizont maturation inhibition test by Sadiq *et al*. (2017). Additionally, all extracts demonstrated schizonticide action against *Plasmodium falciparum* by preventing the growth of mature schizonts after 96 hours.

Antidiabetic and antihyperlipidemic activity

Acacia's antidiabetic qualities have been validated by earlier research. Furthermore, research has indicated that this herb can promote the pancreatic beta cells' production of insulin (Roozbeh *et al.,* 2017). An ethanolic extract of Acacia leaves (300 mg/kg) was administered to the hyperglycemic rats (alloxan model) for six weeks, which led to blood sugar control and a return to the normal lipid profile. Furthermore, the study confirmed that glibenclamide was not as effective as the Acacia extract (Natarajan and Srinivasan, 2015).
According to research, mice with diabetes induced by alloxan (186.9 mg/kg) respond best to an intraperitoneal injection of an aqueous extract of Acacia stem bark in terms of lowering blood sugar levels.

The effect was compared to both insulin and glibenclamide (Mukundi *et al.,* 2015).

Anticancer and antimutagenic activity

In a study, it was found that the ethanolic extract of *Acacia* leaves had cytotoxic activity against two cell lines, Hela (IC50 = 53.6 µg/ml) and Vero (IC50 = 28.9 µg/ml). In contrast, the extract did not show any toxicity towards the erythrocytes in humans or rats (Kalaivani *et al.,* 2011).

A subsequent study also concluded that the *Acacia* extract could be used to treat cancers in humans. As the methanolic extract of the aerial parts of the *Acacia* (10 mg/kg) showed a significant reducing effect on the development of the solid tumor induced in BALB/c mice by Dalton's ascitic lymphoma (DAL). Besides, the extract increased the number of white blood cells (WBCs) and hemoglobin compared to the ascitic tumor group (Sakthivel *et al.,* 2012).

In addition, the crude (chloroform, n-hexane, and ethyl acetate) extracts of *Acacia* root showed cytotoxic effect against the brine shrimp lethality bioassay, and it was dose-dependent (Hussain and Hussain, 2012).

Antipyretic, anti-inflammatory and antinociceptive activities

In comparison to paracetamol (150 mg/kg), the aqueous extract of Acacia root (200 and 400 mg/kg) had an analgesic effect (acetic acid-induced writhing, hot plate, and tail immersion) and an antipyretic effect (Brewer's yeast generated pyrexia) (Alli *etal*., 2015).In experimental mice, the aqueous extract of Acacia bark (150 mg/kg) decreased pain (formalin-induced writhing), inflammation (formalin created inflammation), and temperature (brewer's yeast caused pyrexia) (Safari *etal*., 2016).
In rats with pylorus ligation, an aqueous ethanolic extract of Acacia pods (50% and 70%) had antiulcer benefits, according to a study by Bansal and Goel (2012). Additionally, the 70% aqueous ethanolic extract shown a therapeutic effect against ulcers caused by swimming stress and ulcers caused by non-steroidal anti-inflammatory drugs.

Anti-hypertensive activity

Reddy *et al.* (2018), recently showed an anti-hypertensive impact of the ethanolic extract of *Acacia* pods in the model of chicks. This effect was consistent with increasing the dose (100 µg, 1, and 3 mg/kg) and comparable to that of isoprenaline.

Antispasmodic and antidiarrheal activities

In an experiment conducted on rats infected with diarrhea with castor oil, researchers found a dose-dependent antidiarrheal effect of the ethyl acetate extract of *Acacia* pods. The extract reduced the number of times of the informed stools (200, 400, and 600 mg/kg) and reduced intestinal transit of charcoal (400 mg/kg) (Sanni *et al.,* 2010).

Gilchrist *et al.* (2019), showed that the aqueous extract of *Acacia* bark had an anti-colic effect, as the extract showed an ability to reduce spasms caused by 1µ Macetylcholine (IC50 = 13.02 µg/ml) and 160 µg/ml Barium chloride (IC50 = 117.2 µg/mL) on the isolated rat duodenum.

Antioxidant activity

The ethanolic extract of *Acacia* leaves showed significant antioxidant activity in carotene bleaching assay similar to butylated hydroxytoluene activity (Kalaivani *et al.,* 2011).

The methanolic and aqueous extracts of *Acacia* pods possess significant antioxidant capacity as appeared by reducing DPPH, nitric oxide, and lipid peroxide production (Khan and Gohel, 2014).

In the 2,2-diphenyl-1-picrylhydrazyl (DPPH) test, the ethanolic extract of Acacia leaves shown strong antioxidant effectiveness (IC50 = 75.2 µg/ml) in addition to a notable hydroxyl radial scavenging effect (IC50 = 159.6 µg/ml). The extract's overall antioxidant capacity is equivalent to 152.8 µg/ml of ascorbic acid. The extract from acacia leaves significantly reduces the oxidative stress that the Saccharomyces cerevisiae system produces. The active components of acacia, phytol and α-tocopherol, may be responsible for these antioxidant benefits (Subhaswaraj*et al*., 2017).

The ethanolic extract of Acacia leaves, pods, and bark showed strong antioxidant activity in favor of the leaves extract when tested using the ferric reducing test, the reducing power capacity assay, and the percent inhibition of lipid peroxidation (Sadiq *et al*., 2017). Furthermore, in tests for β-carotene-linoleic acid, hydrogen peroxide scavenging, metal chelating, and DPPH, the methanolic extract of Acacia leaves showed a good antioxidant capacity (94.3%). Total flavonoid contents, total phenolics constituents, and antioxidant efficacy were found to be positively correlated (Yadav*et al*., 2018).

Table 3 : Medicinal properties and chemical compounds extracted from *Acacia nilotica*

Part used	Medicinal properties and chemical compounds	Source
Stem bark	Sexually transmitted diseases, bark is reported to have antibacterial, antioxidant, antimutagenic, and cytotoxic activity	Donalisio*et al.,* (2017)
Fruits	The fruits are sold for medicinal purposes to some West African countries such as Nigeria	Moussa (2018)
Leaves	The leaves are used as antibacterial, chemo preventive , astringent, anti-inflammatory and as anti-Alzheimer.	Rather*et al.,* (2015)

Flower	53 Phytoconstituents present in Petroleum ether extract of *Acacia nilotica* flower, flowers are used in gastrointestinal disorders	Leela and Ilavarasan (2019)
Roots	The root is used against tuberculosis and tumors of ear, eye, and testicles	Rather *et al.,* (2015)
All parts of the plant	All parts of the *Acacia nilotica* have medicinal properties	Donalisio*et al.,* (2017)

THREATENED AND ENDANGERED SPECIES OF MEDICINAL PLANTS IN NIGERIA

Nigeria's biodiversity loss is getting worse. The threat of drought and desertification, which causes soil erosion and completely diverts the ecology, was present in the Sahel region and some areas of the Savannah region that bordered the Niger Republic. The main causes of this negative impact are widespread overgrazing, ongoing deforestation, ground cover loss, and other poor farming methods (Borokini, 2014). Tree-cutting, ground-cover loss, and ongoing overgrazing by Fulani herdsmen's livestock are the main causes of the confrontational impact. Furthermore, the majority of the plants that were destroyed were medicinal plants that Sahelian communities collected, traded, and relied on for their livelihood.

There is therefore a need for a more sustainable Forest resource management to ensure that the current generation utilises the available natural resources wisely without compromising the availability of the resources for future generations (Chukwuma*etal*., 2015; Taylor, 2015). With a loss of the natural vegetation, people are not only losing a valuable medicinal resource, but also the possibility of discovering new medicines (Aronson *etal*., 2010; Chukwuma *etal*., 2015).
One of the recent efforts by the Nigerian Government to reduce the loss of biodiversity was the signing of the bill by the President of Nigeria on 30 December 2016 to stop trafficking of endangered species (Wakili, 2016).

Consequently, among the species that were threatened include: *Azadirachta indica*, *Neocarea macrophylla* (Sabine) Prance ex F.White (Gawasa), *Sclerocaryabirrea* (A. Rich) Hochst. (Danya), *Detariummicrocarpum* Harms. (Taura), *Prosopis africana* (Guill. and Perr.) Taub. (Kirya), *Acacia africana*, *Acacia nilotica*. (Gmaraldeen*etal*., 2016). Though numerous international and national summit have been conducted towards ways to tackle the menace of desertification but apparently failed in the Sahel regions, notably because majority of the populace relied on the natural resources for their well-being.

Since both rural and urban communities have chosen to use medicinal plants as a complementary and alternative means of treating their illnesses, the Nigerian Ministry of Health has faced difficulties for many years. Additionally, excessive and unsustainable cutting, coupled with a lack of enforcement, has put some species in danger of going extinct (Osawaru*etal*., 2010).
Since 1990s, some large farm has caused enormous deforestation of the natural habitats depicting as the major source of loss. Thus, drastic depletion of fire-wood species like neem tree, *Acacia nilotica*, *Acacia seyal* was very prominent (Borokini, 2014). Consequently, the Sahel region is characterized by small, widely disseminated, small-leaved trees, mainly *Acacia* species such as *Acacia tortilis* subsp. raddiana, *Acacia seyal*, *Acacia nilotica* and *Acacia senegal*.

During the dry season, an equally high proportion of the trees were deciduous. *Anogeissusleiocarpus*, *Sclerocaryabirrea*, *Combretum micranthum*, and *Guiera senegalensis* were among the species. Radar image interpretation effectively classifies the following (mostly) shrub vegetation types as wooded formations: "Dense shrub grassland" and "shrub grassland," which provide a woody cover of shrubs such as *Combretum* spp., *Guiera senegalensis*, *Acacia* species, *Calotropis senegalensis*, and *Boscia senegalensis* (Borokini, 2014).
Threatened plant species present a problem. Nigeria has more than 5,000 recorded plant species, 22,090 animal species, including insects and 889 bird species, and 1,489 microorganism species, according to the Federal Environmental Protection Agency's (FEPA) 1992 country report, Fourth National Biodiversity Report (2010).

According to the estimate, 0.14% of animals and insects are threatened and 0.22% are endangered, while 0.4% of plant species are threatened and 8.5% are endangered. According to the IUCN (2004), a species is deemed endangered if its population size declines over time, its numbers are assessed to be below 2,500 mature individuals, and its extinction rate is predicted to be at least 20% within 20 years. An endangered species is unlikely to survive if the factors posing the threat persists (Ezealor, 2002). Many medicinal plants face extinction and/or severe genetic loss, but detailed information is lacking especially in developing countries. For most of the endangered medicinal plant species, no conservation action has been taken.

It is therefore necessary to initiate systematic cultivation and conservation of medicinal plants in order to conserve biodiversity and to protect endangered and threatened plant species (Belinda, 2008). The Nigerian Red List has a total number of 189 plant species, out of which 138 are categorized as vulnerable, while 18 are endangered, 16 are critically endangered, 16 are at low risk and 1 species belongs to the data deficient category (Augustine, 2010).

Table 4 : Threatened Medicinal Plants of Kano Flora

Family Name	Plant Name	Common Name	Local Name
Amaranthaceae	*Ceiba pentandra*	Silk cotton tree	Rimi
Anacardiaceae	*Lannea macrocarpa*	Tree grapes	Faru
Asteraceae	*Aspiliahelianthoides*	Aspilia	Kalankuwa
Aristolochiaceae	*Aristolochia albida*	Dutchman's pipe	Duman duste
Bignoniaceae	*Kigelia Africana*	Sausage tree	Rawaya
Burseraceae	*Balsamodendronafricanum*	Myrrh	Dashi
Capparaceae	*Capparis tomentosa*	Woolly caper bush	Kabdodo
Caesalpinaceae	*Burkea Africana* *Cassia arareh*	Wild syringe Cassia	Namijinkirya Marga
Combretaceae	*Anogeissusleiocarpus* *Combretum glutinosum* *Terminalia avicennoides*	Chewing stick tree Kattakara Baushe	Marke Kattakara Baushe
Convolvulaceae	*Evolvulusalsinoides*	Morning glory	Kafi malam
Fabaceae	*Acacia nilotica* *Acacia seyal* *Acacia sieberiana* *Erythrina senegalensis* *Dannielliaoliveri* *Prosopis africana*	Gum Arabic tree Shittah tree Paper bark thorn Coral tree African copaiba balsam African mesquite	Bagaruwa Dimshe Farar Kaya Minjiriya Maje Kirya
Mimosaceae	*Albizia chevalieri*	Jaree-hi	Katsari
Moraceae	*Ficus glumosa* *Ficus sur* *Ficus sycomorus*	Mountain fig Bush fig White fig	Kawari Haguguwa Farin baure
Olacaceae	*Ximenia americana*	Yellow plum	Tsada
Plantaginaceae	*Scopiara dulcis*	Sweet broom weed	Ruma fada
Polygalaceae	*Securidacalongipedunculata*	Violet tree	Sanya
Rubiaceae	*Fadogiaagrestis* *Mitragyna inermis* *Naucleadiderrichi*	Black aphrodisiac False abura African peach	Baking gagai Giyayya Tafashiya
Sterculiaceae	*Sterculia setigera*	Karaya gum tree	Kukuki
Vitaceae	*Cissus quandrangularis*	Devil's backbone	Tawatsa

Source: Umar Suleiman Abubakar *et al.* (2018)

Table shows the most frequently threatened species of medicinal plants in Kano state, Nigeria. The loss of these plants was attributed to urbanization, deforestation, expansion of agricultural activities and unsustainable collection of the plants. These plant species are at a higher risk of becoming extinct.

CONSERVATION OF MEDICINAL PLANTS

Conservation strategies

Medicinal plants are changing or going extinct extremely quickly. Traditionally, the majority of therapeutic plants are collected from their natural habitat in the wild. However, medicinal plants face the grave threat of extinction due to numerous detrimental human and environmental factors, including overharvesting, deforestation, desertification, and global warming, to name a few (Kankara*et al.,* 2015). According to Amujoyegbe*et al*. (2012), medicinal plants are becoming less and less common. This is due to the fact that they are used for a variety of uses, including trade, food, firewood, building poles, and timber, in addition to their high demand for primary healthcare. The significant cultural, livelihood, or economic aspects that medicinal plants have in people's lives give them a unique significance in conservation(Hamilton, 2004). Growing amounts of medicinal plant resources, mostly from wild populations, are being gathered. A species' ability to reproduce is irreversibly diminished below a certain threshold (Semwal *et al*., 2007).

In situ conservation

The "on-site conservation" of wild genetic diversity in its native habitat is the focus of the in-situ conservation approach.This pertains to the preservation of living organism samples in their native environments (IUCN, 2010). This kind of conservation is accomplished by securing the survival of as many wild species as possible in managed environments, such as plantation woods and farms, as well as by designating areas as natural reserves and wild nurseries. The majority of medicinal plants are indigenous species, and the primary source of their therapeutic qualities is the presence of secondary metabolites that react to stimuli in their natural habitats but might not express themselves in cultivation (Grelle, 2009).

Natural communities and their complex web of relationships can be preserved and indigenous plants can be protected by in situ conservation of entire communities (Gepts, 2006). Furthermore, in situ conservation promotes the connection between resource conservation and sustainable usage (Long *et al*., 2003) and expands the amount of diversity that may be preserved (Forest *et al*., 2007).

Natural reserves

According to Rodriguez *et al*. (2007), natural reserves or parks are protected regions with significant wild resources established to maintain and restore biodiversity.One of the main reasons for the depletion of resources for medicinal plants is habitat degradation and destruction (Camm *et al*., 2002). According to Rodriguez *et al*. (2007), natural reserves are areas of significant wild resources that are conserved in order to

maintain and replenish biodiversity. It is necessary to evaluate the contributions and ecosystem functions of different habitats in order to conserve medicinal plants by safeguarding important natural habitats (Liu *et al*., 2001).

Wild nurseries

Due to competing land uses and financial considerations, it is not feasible to designate all natural wild plant habitats as protected areas (Soule *et al*., 2005; Kramerand Havens, 2009). For species-oriented cultivation and domestication of endangered medicinal plants, a wild nursery is set up in a protected area, natural habitat, or a location that is close to the plants' natural growth region (Olsen, 2008). Wild nurseries can offer an efficient method for in situ conservation of medicinal plants that are endemic, endangered, and in demand, even though the populations of many wild species are severely impacted by overexploitation, habitat degradation, and invasive species (Liu *et al*., 2011; Li and Chen, 2007).

Ex situ conservation

> The "off-site conservation" of wild genetic resources is the focus of the ex-situ technique of conservation. The preservation of living creature samples outside of their natural habitat is referred to here (IUCN, 2010). Many medicinal plant species have life-threatening numbers in their natural populations, making them unsuitable for in-situ conservation efforts. The earliest and most well-known ex-situ conservation techniques are found in zoos and botanical gardens (Corker, 2002). Other contemporary ex-situ conservation techniques that include preserving the reproductive organs of threatened species for potential future reproduction or propagation include;

- Seed bank,
- Gene bank,
- Germplasm bank,
- *In-vitro* storages (IUCN, 2010).

Botanic gardens

Botanic gardens are the least expensive way to preserve endangered medicinal plant species, according to Sofowora (2008). However, in Nigeria, efforts to conserve endangered plant species through botanical gardens are not being given the attention they need; instead, some of the current gardens are being continuously demolished to make room for new projects (Njoku, 2000). In addition to maintaining ecosystems to improve the survival of rare and endangered plant species (Huang*et al*., 2002), botanic gardens are crucial for ex situ conservation (Havens *et al*., 2006).

Seed banks

Seed banks are advised to help maintain the biological and genetic diversity of wild plant species because they provide a more effective means of storing the genetic diversity of many medicinal plants ex situ than botanic gardens (Li and Pritchard, 2009). Plant samples can be accessed reasonably quickly through seed banks for property evaluation, which yields useful information for preserving the remaining natural populations (Li and Pritchard, 2009). Reintroducing the plant species into the wild and actively supporting the restoration of wild populations are the difficult tasks associated with seed banking (Li and Pritchard, 2009).

Field Gene banks

Germplasm Technique of Conservation

> Land and labor are needed for annual or perennial replanting in order to conserve the germplasm of vegetative propagated plants and forest species in the field gene banks. However, reduced growth storage, also known as in-vitro storage, uses less capacity in growth rooms and keeps thousands of genotypes together while reducing disease and pest attacks in the culture vessels. Additionally, it removes the necessity of drawn-out processes for germplasm exchange and movement (Kasaganaand Karumuri, 2011). The following are some additional drawbacks of this method:

- Certain plants may not produce viable seeds,
- Certain plant seeds deteriorate rapidly due to seed-borne pathogens,
- Certain plant seeds are heterogenous and are not suitable for maintaining true to type genotypes.

Cryopreservation Technique of Conservation

Cryopreservation is defined as the viable freezing of biological material and their subsequent storage at ultra-low temperature (-196°C) using liquid nitrogen (Kasagana and Karumuri, 2011). New Cryopreservation techniques include;

- Encapsulation and dehydration,
- Vitrification,
- Encapsulation and vitrification,
- Dessication,
- Pre-growth,
- Pre-growth and Dessication,
- Droplet freezing.

Cultivation practice

Domestic cultivation is a common and widely accepted technique, despite the fact that wild-harvested medicinal plant resources are generally seen to be more effective than those that are farmed (Gepts, 2006; Joshi and Joshi, 2014; Leung and Wong, 2010). Cultivation offers the chance to employ novel approaches to address issues that arise in the manufacturing of medical plants, including inadequate levels of active substances, pesticide contamination, toxic components, and incorrect botanical origin identification (Raina *et al*., 2011). Controlled growth conditions can guarantee production stability and increase the yields of active chemicals, which are mostly always secondary metabolites.

To achieve higher yields of the desired goods, cultivation techniques are made to supply the ideal amounts of water, nutrients, optional additives, and environmental elements including temperature, light, and humidity (Wong *et al*., 2014). Additionally, increasing cultivation helps recover their wild resources, lowers their prices to a more affordable range, and reduces the harvest volume of therapeutic plants (Olsen, 2007).

Good agricultural practices (GAP)

To control production, guarantee quality, and make it easier to standardize herbal medications, good agricultural practices (GAP) for medicinal plants have been developed (Chan *et al*., 2012). By using existing knowledge to address a variety of issues, a GAP method guarantees high-quality, safe, and pollution-free herbal medications (or crude drugs) (Muchugi*et al*., 2008). According to Makunga*et al*. (2008), GAP encompasses a wide range of comprehensive items, including the ecological habitat of production sites, germplasm, cultivation, collection, and quality aspects of pesticide detection, as well as macroscopic or microscopic authentication, chemical identification of bioactive compounds, and metal element inspection.

Organic farming has received increasing attention for its ability to create integrated, humane, and environmentally and economically sustainable production systems for medicinal plants (Macilwain, 2004).

Table 5: The experts most needed for a programme of conservation and sustainable utilization of medicinal plants

Experts	Discipline
Agronomists	To improve techniques for cultivating medicinal plants
Conservation campaigners	To persuade the public of the need to conserve medicinal plants
Ecologists	To understand the ecosystems in which medicinal plants grow

Ethnobotanists	To identify the use of plants as medicines in traditional societies
Health Policy-makers	To include conservation and utilization of medicinal plants in their policy and planning
Horticulturists	To cultivate medicinal plants
Legal Experts	To develop effective legal mechanisms that ensure that collection of medicinal plants is at levels that are sustainable
Park Managers	To conserve medicinal plants within their parks and reserves
Park Planners	To ensure the park and reserve system contains the maximum diversity of medicinal plants
Pharmacognosists	To study the application of medicinal plants
Plant Breeders	To breed improved strains of medicinal plants for cultivation
Plant Genetic Resource Specialists	To assess and map the genetic variation in medicinal plants and maintain seed banks of medicinal plants
Plant Pathologists	To protect the cultivated medicinal plants from pests and diseases without using dangerous chemicals
Religious Leaders	To promote a respect for nature
Resource Economists	To evaluate the patterns of use and the economic values of medicinal plants
Seed Biologists	To understand the germination and storage requirements of the seed of different medicinal plants
Taxonomists	To identify the medicinal plants accurately
Traditional Health Practitioners	To provide information on the uses and availability of medicinal plants

REFERENCES

Sofowora, A. (2008). "*Medicinal Plants and Traditional Medicine in Africa*", 3rd Edition. Spectrum Books Ltd.,Ibadan, Nigeria.

Ezealor, A.U. (2002). "*Critical Sites for Biodiversity Conservation in Nigeria*", Nigerian Conservation Foundation, Lagos.

Abdelbaset-Ismail A., Pedziwiatr, D., Suszyńska, E., Sluczanowska-Glabowska, S., Schneider, G., Kakar, S.S. and Ratajczak, M.Z. (2016).Vitamin D3 stimulates embryonic stem cells but inhibits migration and growth of ovarian cancer and teratocarcinoma cell lines.*Journal of Ovarian Research*, 9 (1):1-12, 10.1186/s13048-016-0235-x.

Abd El-Ghani, M.M. (2016). Traditional medicinal plants in Nigeria: An overview.*Agriculture and Biology Journal of North America*; 7(5):220-247.

Abdel-Moneim, A.E, Othman, M.S. and Aref, A.M. (2014).*Azadirachta indica* attenuates cisplatin-induced nephrotoxicity and oxidative stress*. BioMed Research International*, (14)1-19, 10.1155/2014/647131.

Agera, S.I. and Dau, J.H. (2012). "Seed processing, seed banks and seed conservation: A review;" *Nigerian Journal of Education, Health and Technology Research* (NJEHETR); 3(2): 8-18.

Aiyeloja, A.A., Bello, O.A. and Akintayo, M.E. (2010). Evaluation of common medicinal plants used for family planning in Nigeria. *Journal for Applied Research* (JFAR). 2(1): 1-5.

Ajewole, O. and Garba, M. (2010). "Survey and Governance of street trees in Damaturu, Nigeria". *Journal of Tropical Forest Resources.*26: 116-129.

Akinyemi, B. (2000). Recent concept in plaque formation. *Journal of Clinical Pathology*, 30:13-16.

Alam A., Haldar, S., Thulasiram, H.V., Kumar, R., Goyal, M., Iqbal, M.S. and Bandyopadhyay, U. (2012).Novel anti-inflammatory activity of epoxyazadiradione against macrophage migration inhibitory factor: Inhibition of tautomerase and proinflammatory activities of macrophage migration inhibitory factor.*Journal of Biological Chemistry*, 287 (29): 24844-24861, 10.1074/jbc.M112.341321.

Al Akeel, R., Mateen, A., Janardhan, K. and Gupta, V.C. (2017).Analysis of anti-bacterial and anti oxidative activity of *Azadirachtaindica* bark using various solvents extracts*. Saudi Journal of Biological Sciences*, 24 (1):11-14, 10.1016/j.sjbs.2015.08.006.

Al-Hashemi, Z.S.S. and Hossain, M.A.(2016).*Biological activities of different neem leaf crude extracts used locally in Ayurvedic medicine.* Pacific Science Review A: Natural Science and Engineering, 18 (2):128-131, 10.1016/j.psra.2016.09.013.

Ali, A., Akhtar, N., Khan, B.A., Khan, M.S., Rasul, A., Khalid, N., Waseem, K., Mahmood,T. and Ali, L. (2012). "*Acacia nilotica:* A plant of multipurpose medicinal uses". *Journal of Medicinal Plant Research*; 6: 1492-1496.

Alli, L., Mikhail, O., Abdulfatai, A., Musbau, A., Tijani, A., Salawu, O. (2015). Antipyretic and analgesic activities of aqueous extract of *Acacia nilotica* root. *Biokemistri*; 26: 55-62.

Alli, L., Adesokan, A. and Salawu, A. (2016). Antimalarial activity of fractions of aqueous extract of *Acacia nilotica* root. *Journal of Intercultural Ethnopharmacology;* 5: 180-5.

Alzohairy, M.A. (2016).Therapeutics role of *Azadirachtaindica* (Neem) and their active constituents in diseases prevention and treatment. Evidence-Based Complementary and Alternative Medicine, 10.1155/2016/7382506.

Amujoyegbe, B.J., Agbedahunsi, J.M. andAmujoyegbe, O.O. (2012). Cultivation of medicinal plants in developing nations: means of conservation and poverty alleviation. *International Journal of Medical Aromatic Plants*, 2(2): 345-353.

Anoka A.N. (2012).*Herbal medicine used in the treatment of Malaria: Vernonia amygdalina: An overview of evidence and pharmacology.* In: Acree B, editor. Toxicity and Drug Testing. Croatia: InTech.

Aronson, J., Blignaut, J.N., Milton, S.J., Le Maitre, D., Esler, K.J. and Limouzin, A. (2010) "Are socioeconomic benefits of restoration adequately quantified? A meta-analysis of recent papers (2000-2008) in restoration ecology and 12 other scientific journals", *Restoration Ecology,*18(2), 143-154.

Arumugam A., Agullo, P., Boopalan, T., Nandy, S., Lopez, R., Gutierrez, C. and Rajkumar, L.(2014). Neem leaf extract inhibits mammary carcinogenesis by altering cell proliferation, apoptosis, and angiogenesis.*Cancer Biology and Therapy*, 15 (1) (2014), pp. 26-34, 10.4161/cbt.26604.

ASICUMPON.(2005).*Checklist of Medicinal Plants of Nigeria and their Uses*. Enugu, Nigeria: Trinity-Biz Publishers.

Akin-Osanaiya, B.C., Nok, A.J.and Ibrahim, S. (2013). Antimalarial effect of Neem leaf and Neem stem bark extracts on *Plasmodium berghei*infected in pathology and treatment of malaria," *International Journal of Research in Biochemistry and Biophysics,* 3(1):7-14.

Balakrishnan, B., Paramasivam, S. and Arulkumar, A. (2014). Evaluation of the lemongrass plant (*Cymbopogon citratus)* extracted in different solvents for antioxidant and antibacterial activity against human pathogens. *Asian Pacific Journal of Tropical Disease.* 4: S134-S139.

Baligar, N. S., Aladakatti, R. H., Ahmed, M. and Hiremath, M. B. (2014). Evaluation of acute toxicity of neem active constituent, nimbolide and its hepatoprotective activity against acute dose of carbon tetrachloride treated albino rats. *International Journal of Pharmaceutical Sciences and Research,* 5(8):3455–3466.

Baligar, N.S., Aladakatti, R.H., Ahmed, M. and Hiremath, M.B.(2014).Hepatoprotective activity of the neem-based constituent azadirachtin-A in carbon tetrachloride intoxicated Wistar rats*. Can J PhysiolPharmacol*., 92(4):267-77.

Baligar, N.S., Aladakatti, R. H., Ahmed, M. and Hiremath, M. B. (2014). Evaluation of acute toxicity of neem active constituent, nimbolide and its hepatoprotective activity against acute dose of carbon tetrachloride treated albino rats.*International Journal of Pharmaceutical Sciences and Research,* 5(8):3455–3466.

Banerjee, S., Ghosh, T., Barik, S., Das, A., Ghosh, S.,Bhuniya, A. and Baral, R. (2014).Neem leaf glycoprotein prophylaxis transduces immune dependent stop signal for tumor angiogenic switch within tumor microenvironment*. PLoS ONE*, 9 (11) (2014), 10.1371/journal.pone.0110040.

Bansal, V.K. and Goel, R.K. (2012). Gastroprotective effect of *Acacia nilotica* young seedless pod extract: Role of polyphenolic constituents*. Asian Pacific Journal of Tropical Medicine,* 5: 523-8.

Banso, A. (2009). Phytochemical and antibacterial investigation of bark extracts of *Acacia nilotica.Journal of Medicinal Plants Research;* 3: 082-5.

Barua, C. C., Talukdar, A., Barua, A. G., Chakraborty, A., Sarma, R. K. and Bora, R. S. (2010). Evaluation of the wound healing activity of methanolic extract of *Azadirachta Indica* (Neem) and *Tinospora cordifolia* (Guduchi) in rats. *Pharmacologyonline*; (1):70–77.

Basir, S. and Shailey, S. (2012).*Strengthening of antioxidant defense by Azadirachta indica* in alloxan-diabetic rat tissues*. Journal of Ayurveda and Integrative Medicine*, 3 (3):130.10.4103/0975-9476.100174.