Journal Homepage: -www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI:10.21474/IJAR01/8885
DOI URL: http://dx.doi.org/10.21474/IJAR01/8885

*RESEARCH ARTICLE*

# A REVIEW OF OPPORTUNITIES AND CHALLENGES IN CONSERVATION AND USE OF MEDICINAL AND AROMATIC PLANTS IN NIGERIA.

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## Manuscript Info

***Manuscript History***
Received: 11 February 2019
Final Accepted: 13 March 2019
Published: April 2019

***Key words:***
Medicinal and Aromatic Plants (MAPs), Natural medicine, Herbal medicine, Opportunities, Challenges.

## Abstract

Nature deposited in Nigeria several beneficial plant materials especially medicinal and aromatic plants (MAPs) for the treatment of ailments through herbal preparations, and for other culinary, traditional, medical and pharmaceutical uses. Preparation of natural medicine and production of herbal remedies by use of MAPs have proved to be a great alternative to the substandard production, cost and inaccessibility of synthetic orthodox medicines to rural dwellers. Despite the opportunities, there have been serious challenges in conservation and use of medicinal and aromatic plants in Nigeria. The opportunities and challenges in the conservation and use of medicinal and aromatic plants (MAPs) in Nigeria were therefore reviewed in this paper. Vital recommendations were also made as solutions to the challenges. Cultivation and inclusion of MAPs in cropping systems, inclusion of natural medicine and herbal products in healthcare delivery system, production of raw materials, income generation through exportation, etc are some opportunities in conservation and use of MAPs in Nigeria. Challenges include: difficulty to cultivate some species and varieties, over-exploitation of medicinal and aromatic plants, adulteration of herbal products, threatened/endangered plant species and biodiversity losses, deforestation and urbanization, overall quality, safety, efficacy, preservation and dosage of herbal remedies, cultural practices, lack of standardization and documentation, ignorance, poverty and illiteracy among rural dwellers, lack of proper education of the masses and prioritization of species to be conserved, lack of conservation programmes, etc. Recommendations include: Sustainable harvesting and deliberate cultivation of MAPs, establishment of medicinal plants conservation centres in Nigeria, documentation and digitization of information on medicinal plants, protection of wild species *in-situ*, and *ex-situ*, cultivation in botanical gardens, training of traditional medicine practitioners (TMPs) and herbalists by means of workshops, seminars or courses to educate them on some important aspects of their practice.



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## Introduction:

Nigeria is richly endowed with indigenous plants, which are used in herbal medicine to cure diseases and heal injuries (Okwu, 2007; Dike and Obembe, 2012). Medicinal plants in Nigeria are used for making herbal medicine. Herbal medicine, sometime also called botanical medicine, uses herbs to make products more recently and widely accepted as herbal medicinal products which are used for therapeutic or medicinal purposes (Mafimisebi et al. 2013). Medicinal plants contribute significantly to rural livelihoods (Marshall, 2011; Amujoyegbe et al. 2012; Karki, 2015), and are of socio-economic importance to the rural population both as source of raw material for health care remedies and as a source of income (Elekwa et al. 2017). The use of traditional medicine in developed as well as developing countries as basis for the treatment of many ailments has been in existence for thousands of years and there is no doubt that their importance has been widely acknowledged (Idu and Onyibe, 2007; Chukwuma et al. 2015). Medicinal and aromatic plants have been important resources for human health care from prehistoric times to the present day (Dike and Obembe, 2012; Mahomoodally, 2013; Thillaivanan and Samraj, 2014). Medicinal plants can be used as medicines, foods or materials for pharmaceutical preparations (Mamedov, 2012, Orji et al. 2013), treatment for skin diseases (Egharevba and Ikhatua, 2008), treatment of obstetric and gynecological conditions, such as birth control/family planning, complications during pregnancy/child birth and other problems associated with infertility (Aiyeloja et al. 2010; Kankara et al. 2015; Saalu, 2016). People on all continents have used hundreds to thousands of indigenous plants for treatment of ailments since prehistoric times (Foladun and Imieje, 2013; Monier and El-Ghani, 2016; Elekwa et al. 2017). MAPs are primarily used for therapeutic, aromatic and/or culinary purposes as components of cosmetics, medicinal products, health foods and other natural health products. They are also the starting materials for value-added processed natural ingredients such as essential oils, dry and liquid extracts and oleoresins. There is a clear industrial demand for MAPs thanks to the increased production of herbal health care formulations; herbal based cosmetic products and herbal nutritional supplements. Lubbe and Verpoorte (2011) noted that specialty materials such as essential oils, pharmaceuticals, colorants, dyes, cosmetics and biocides are obtained from plants. According to Monier and El-Ghani (2016), numerous medicines have been derived from the knowledge of tropical forest people and clearly there will be more in the future.

Aromatic plants are plants that possess odorous volatile substances which occur as essential oil, gum exudate, balsam and oleoresin in one or more parts namely: root, wood stem, foliage, flower and fruit. The characteristic aroma is due to a variety of complex chemical compounds (Joy et al. 2001). Aromatic plants are planted in the garden specifically for their distinctive smell and include everything from the spring blooming tulips to plants that bloom later like lavender, hyssop, or herbal gardens. Lilacs are known for their unique, distinctive aromatic blooms. Aromatic plants, also known as herbs and spices, have been used since antiquity as folk medicine and as preservatives in foods. The best-known aromatic plants, such as oregano, rosemary, sage, anise, basil, etc., originate from the Mediterranean area. They contain many biologically active compounds, mainly polyphenolics, which have been found to possess antimicrobial, antioxidant, antiparasitic, antiprotozoal, antifungal, and anti-inflammatory properties (Christaki et al. 2012). Plants that produce aromatic substances are not just enjoyed in the garden, but used to make commercial perfumes, cooking amendments, air fresheners, and even for medicinal purposes. Aromatic plants and flowers can have a true impact indoors by adding pleasurable scents to the environment. The science of using aromatic plants to treat certain conditions is called aromatherapy and is used to treat headaches, stress, sleep disorders, and other conditions. Other aromatic plants are also known for their flavor and are harvested for use in the kitchen as herbs and spices. The foliage or blooms of certain aromatic plants retain their fragrance and can be dried and stored or hung in a house, providing a sweet scent for months to come.

**The Opportunities in Conservation and Use of MAPs in Nigeria:**

Cultivated MAPs material is increasingly preferred by herbal industry, because it is easier to predict plant yield, quality and composition from farmed sources comparing with raw material gathered from the wild. MAPs are natural products, environmentally friendly, easily available, cheap and curative more than many substandard orthodox medicines imported into the country today (Egharevba and Ikhatua, 2008). Cultivation also reduces the possibility of plant misidentification and adulteration. There are ubiquitous advantages of MAPs cultivation such as: production of raw material of a standard quality, use of available machinery and of existing simple processing facilities, following with more rational utilization of soil resources and yield planning, achievement of financial effects, and preservation of species whose collection is prohibited (Dajic-Stevanovic and Pljevljakusic, 2015). According to Elekwa et al. (2017), increase in population, inadequate supply of orthodox drugs, prohibitive cost of treatment, side and toxic effects of many synthetic drugs, resistance of some diseases to synthetic drugs have led to increased emphasis on the use of plant materials as main sources of medicine for a wide variety of human diseases. Aiyeloja et al. (2010) identified twenty-three (23) very useful plant species for family planning, while Saalu (2016)

listed forty (40) medicinal plants with different antifertility activities. According to Karki (2015), the MAPs sub-sector is a very important source of rural employment. It is clear that MAPs, besides providing multiple conservation benefits, also have huge economic potential and generate cash incomes, particularly for women and poor families that do not have access to agricultural lands and directly participate in markets. According to Thillaivanan and Samraj (2014), these are the opportunities in enhancing the conservation of MAPs: 1. Medicinal plants cultivation. 2. Medicinal plants Exports. 3. In Drug Manufacturing Companies. 4. Teaching profession - Herbal medicine is being taught more in medical schools and pharmacy schools. 5. In the field of plant monographs. 6. Drug inspectors in Indian System of Medicine (ISM). 7. Medical taxonomist. 8. Pharmacognosist. 9. Herbalist & Chiropractors. 10. AYUSH practitioners, Doctors. 11. SRF & JRF in Clinical trials. 12. Clinical and Research opportunities - Without doubt, the therapeutic potential of many herbs is yet to be fully discovered. Example, recent discovery of 'artemisinins', new class of anti-malarial drugs in Chinese herbs supports this assertion. 13. Carrier options in the various newer fields. E.g. Molecular biology, Nano technology etc.

**The Challenges in Conservation and Use of MAPs in Nigeria:**

Medicinal plants are disappearing or being altered at a very fast rate. Most medicinal plants are traditionally obtained from the wild, where they grow naturally. However, as a result of many negative human and environmental factors, such as overharvesting, deforestation, desertification and global warming to mention a few, medicinal plants are faced with the serious problem of extinction (Kankara et al. 2015). Amujoyegbe et al. (2012) noted that medicinal plants are increasingly vanishing, not only because they are highly demanded for primary health care, but also because they cater several other purposes such as trade, food, timber, firewood and building poles. The special significance of medicinal plants in conservation stems from the major cultural, livelihood or economic roles that they play in many people's lives (Hamilton, 2004). Dike and Obembe (2012) stated that vital plant resources of Nigeria are presently threatened by overuse, lack of sustenance and intensified human development activities. It is therefore essential that we work towards conservation of this valuable plant resource, not just with the thought of preserving nature's bounty but for the well-being and livelihoods of indigenous local communities and the society at large, who depend on these resources.

According to Dajic-Stevanovic and Pljevljakusic (2015), the most common issues with which the producers of medicinal plants encountered are the market, abundance and accessibility of wild populations, agro-environmental conditions, labor availability and costs, investments in machinery, post-harvest processing, and profitability of production. According to Saalu (2016), the cost of modern medicine constantly increasing with improvements in modern health technology and in many cases inappropriate to the immediate needs of people in developing and underdeveloped countries. Earlier, Shingu (2005) listed poverty as one of the challenges in conservation of medicinal plants. Other challenges include: mode of use of medicinal plants, loss of medicinal plant species and damage to ecosystem, and lack of standardization.

Direct and coherent efforts to conserve plant species have received relatively little policy attention and research support (Leaman, 2004). Over the years, plant conservationists have made conscious efforts to protect and conserve medicinal plants and thus prevent their extinction. This has not been a straightforward programme due to many problems that militate against it (Orji et al. 2013). For instance, Orji et al. (2013) also listed over – exploitation of medicinal plant species, habitat destruction, financial problems, lack of proper education of the masses and prioritization of species to be conserved as some of the major problems facing medicinal plant conservation in Anambra state of Nigeria.

According to Idu and Onyibe (2007), despite the increasing use of medicinal plants, their future, seemingly, is being threatened by complacency concerning their conservation. Reserves of herbs and stocks of medicinal plants in developing countries are diminishing and in danger of extinction. This is as a result of growing trade demands for cheaper healthcare products and new plant-based therapeutic markets in preference to more expensive target-specific drugs and biopharmaceuticals. Such concerns have stimulated positive legal and economic interest.

Although medicinal and aromatic plants (MAPs) represent a consistent part of the natural biodiversity endowment of many countries in Africa, as well as the world at large (Okigbo et al. 2008), the Fourth National Biodiversity Report (2010) indicated that there are still many challenges that need to be met in Nigeria as many species and habitats continue to decline. This is due largely to habitat loss caused by agricultural intensification practices (including the use of fertilizers and pesticides); increased land drainage; the channelization of water courses and eutrophication of

water bodies; the reduction in extent of hedgerows and loss of farm ponds. Indeed, there are certain problems and challenges to be overcome in order to fully achieve the objective of regulation, standardization and integration of traditional medicines (TM) in Africa.

The ethnocentric and medico-centric tendencies of the Western hegemonic mentality that are usually paraded by most stakeholders in modern medicine remains a very serious challenge (Abdullahi, 2011). Oladele et al. (2011) also observed that the challenges of rural-urban migration in search of social infrastructures obviously poses a threat on the future of traditional medicine practice, the interests of younger generations in acquisition of indigenous knowledge and skill in the use of plant resources for health care delivery are waning. According to Dike and Obembe (2012), plant conservation has long been overshadowed by conservation efforts directed towards animals, and has also been much divided among efforts focused on different production sectors that rely on plant resources – forestry, agriculture, non-wood forest products and efforts targeting different types of ecosystems.

Lack of standardization and documentation of traditional medicine knowledge in Nigeria is another challenge. According to Ikeyi and Omeh (2014), across the continent, many medicinal plants have gone into extinction before documentation. There is rapid depletion of these natural resources due to over exploitation, large scale deforestation, unsustainable arable land use, urbanization, industrialization and lack of conservation programmes. Egharevba and Ikhatua (2008) observed that lack of conservation measures will increase the number of endangered species resulting in individual extinction of numerous plant taxa that are useful as herbal remedies. The wide array of medicinal plants requires different techniques for harvesting, storage and production, yet rarely are these researched and documented. Health traditions in Sub-Saharan Africa are being lost because they are oral and largely undocumented (Shingu, 2005). Mafimisebi et al. (2013) observed that standards and regulations are still not fully developed and operational for the Nigerian herbal, medicinal and aromatic plants (HMAP) market. Earlier, Gideon (2009) noted that in recent time several efforts have been made in Nigeria with regards to documentation of traditional medicine knowledge relating to plant species. In line with these efforts, the Nigeria Natural Medicine Development Agency (NNMDA) was established and saddled with the strategic mandate to research, develop, collate, document and promote natural medicine and Nigeria traditional healthcare system, to integrate same into the national health care delivery system and to contribute to the socio-economic development of the country.

According to Abdullahi (2011), it is a general belief in medical circle that traditional medicine (TM) defies scientific procedures in terms of objectivity, measurement, codification and classification. Even then, there are indications that the physical aspects of TM (i.e. the physical ingredients) can be scientifically studied and analysed. In Yoruba culture, for instance, TM comprises of the physical and spiritual realms. While the physical aspects can be subjected to scientific analysis using the conventional scientific methods of investigation, the spiritual realm may not. Again, if integrated, who provides training to medical doctors on the ontology, epistemology and the efficacies of African TM given the ethnocentric tendencies in modern medicine? That is, who determines the efficacy and effectiveness of TM given the inherent epistemological and ideological characteristic differences of both medicines? The future of medicinal and aromatic plants rests on today's ability to resolve the conflicts between conservation and use, and the shift towards more resource-based agriculture increasingly challenged by the globalization of economies (Padulosi et al. 2002).

Adulteration of herbal drugs is another challenge in conservation of MAPs for production of herbal medicines. Thillaivanan and Samraj (2014) defined drug adulteration as “mixing or substituting the original drug material with other spurious, inferior, defective, spoiled, useless other parts of same or different plant or harmful substances or drug which do not confirm with the official standards”. Adulteration of herbal products can be made in various ways; commonly, adulteration is made by substituting other easily available or cheap plant species or sometimes by spiking of a product with synthetic constituents. Plants collected in the wild may include non-targeted species, especially either by accidental substitution or intentional adulteration.

Growth exploitation and extinction is another challenge of MAPs in Nigeria. Idu and Onyibe (2007) stated that genetic biodiversity of traditional medicinal herbs and plants is continuously under the threat of extinction because of growth-exploitation, environment-unfriendly harvesting techniques, loss of growth habitats and unmonitored trade of medicinal plants. There is a growing recognition that biological diversity including medicinal plants is a global asset of tremendous value to the present and future generations (Shingu, 2005).

Thillaivanan and Samraj (2014) presented the challenges in conservation and application of MAPs to include the following key issues remain:
Management within ranges of risk.  Communication of uncertainty.  Pharmacological, toxicological, and clinical documentation.  Pharmacovigilance.  Understanding why addition of harmful additives works.  evaluating "drug" interactions.  Constraints with clinical trials and people available.  Standardization.  Safety, and efficacy assessment.

**Steps in Evaluation of new herbal products:**
**The evaluation of new herbal products consists of six (6) steps, namely:**
1. Characteristics of new substances. 2. History and pattern of use. 3. Any adverse reaction. 4. Biological action. 5. Toxicity and carcinogenicity, and 6. Clinical trial data.

With respect to the steps above, Singh (2006) noted that some of the major problems in field cultivation of medicinal plants are: 1. Non-availability of verifiable data on availability and consumption of medicinal plants. 2. Absence/ignorance of cultivation technology. 3. Ignorance of cultivation economics (medicinal plants as pure crop may be uneconomical). 4. Land availability due to land ceiling act and state Forest Act. 5. Inadequate irrigation facilities. 6. Non-availability of planting materials.

**The Constraints in Herbal Medicines:**
The current mode of use of medicinal plants in botanical medicine at the grassroots level is a far cry from these requirements and there is no indication that it will get better soon (Shingu, 2005). According to Erah (2002), the major challenges of any pharmaceutical scientist are serious problems with the overall quality, safety and efficacy of herbal products. Preservation and dosage measurement are serious problems in developing countries. The label claim and other information provided for the use of herbal preparation may be far from what is in the 'bottle'. Sharp practices such as the addition of orthodox medicines to herbal preparations by some traditional medicine practitioners (TMPs) have been reported. Different orthodox medicines may be added to herbal preparations with the hope that one of the added drugs may cure the user's ailment. Just because an herb is natural does not mean that it is safe, and claims of remarkable healing powers are often not supported by reliable evidence. Similar constraints include:
 Indiscriminate harvesting and poor post-harvest treatment practices.  Lack of research on the development of high-yielding varieties, domestication etc.  Poor agriculture and propagation methods.  Inefficient processing techniques leading to low yields and poor-quality products.
 Poor quality control procedures.  Lack of current good manufacturing practices.  Lack of research and development (R & D) on product and process development.  Difficulties in marketing.  Lack of trained personnel and equipment.  Lack of facilities to fabricate equipment locally.  Lack of access to latest technological and market information.

With respect to constraints associated with the dealing of herbal medicines, it has been established that both the raw herb and the extract contain complicated mixtures of organic chemicals which may include fatty acids, sterols, alkaloids, flavonoids, glycosides, saponins, tannins, lignans, and terpenes as well as other small molecules such as peptides and oligosaccharides. It is nonetheless often difficult to determine which component, if any, of the herb has biological activity in humans. According to Dajic-Stevanovic and Pljevljakusic (2015), many species are difficult to cultivate because of certain biological features or ecological requirements (slow growth rate, special soil requirements, low germination rates, susceptibility to pests, etc.). In addition, the processing of herbs, such as heating or boiling, may alter the dissolution rate, or even the pharmacological activity of the organic constituents. Similarly, a host of environmental factors, including soil, altitude, seasonal variation in temperature, atmospheric humidity, length of daylight, rainfall pattern, shade, dew, and frost conditions, may affect the levels of components in any given batch of an herb. Other factors, including infections, insects, planting density, competition with other plant species, seeding time, and genetic factors, play an important role. Plant collection for use in botanicals is one of the factors of concern for quality.

The issue of threatened plant species is also another challenge. According to Fourth National Biodiversity Report (2010), a country report published in 1992 by the Federal Environmental Protection Agency (FEPA) indicated that Nigeria possesses more than 5,000-recorded species of plants, 22,090 species of animals, including insects and 889 species of birds, and 1,489 species of microorganisms. It estimated that 0.4% of the plant species are threatened and 8.5 % endangered, with 0.14% of the animals and insects threatened and 0.22% endangered. The International

Union for the Conservation of Nature (IUCN) Red List of Threatened Species (i.e. of globally threatened species) includes 148 animals and 146 plants that are found in Nigeria. Of these, 26 animals and 18 plants are classified as endangered and another three animals and 15 plants are critically endangered worldwide. Furthermore, there are about 7,895 plant species identified in 338 families and 2,215 genera. There are 22,000 vertebrates and invertebrates species. These species include about 20,000 insects, about 1,000 birds, about 1,000 fishes, 247 mammals and 123 reptiles. Of these animals about 0.14% is threatened while 0.22% is endangered. Threats to biodiversity in Nigeria include population pressure, agriculture and habitat destruction, genetic erosion, etc.

Biodiversity loss is also another challenge: For medicinal and aromatic plants, their availability, distribution, and sustainable use have proved to be a good indicator of the environmental health of an ecosystem in general and they play a pivotal role in the provision of incentive measures for biodiversity conservation in developed countries. Every year, the sum total of human knowledge about the types, distribution, ecology, methods of management and methods of extracting the useful properties of medicinal plants is declining rapidly – a continuation of a process of loss of local cultural diversity that has been underway for hundreds of years. According to Mamedov (2012), as billions of people worldwide rely on medicinal plants for health, sustainability and conservation, it must be our first priority. Everything possible should be done to preserve biodiversity of plant ecosystems, especially in tropical rainforests. According to Fourth National Biodiversity Report (2010), available evidence shows that biodiversity is being lost at a disturbing rate in Nigeria. The causes of biodiversity loss are largely related to human factors. These are due to interaction with the environment for development, improved quality of life resulting from industrialization, technological advancement and rapid growth in urbanization. The direct causes of biodiversity loss in Nigeria include the following economic policies, rising demand for forest products, cultural practices, poor law enforcement and weak laws. Factors such as rapid urbanization have collectively increased deforestation and biodiversity loss. For example, increased export demands for primates and birds for research and trade in timber and non-timber species are indirect causes of biodiversity loss in various parts of the country. Low budgetary allocation to the forestry sub-sector has curtailed national efforts to reforest large areas that have been deforested. Consequently, the allowable timber cuts are not replaced adequately hence sustained yield of the forests cannot be attained. Continued timber cut without replacement indirectly leads to biodiversity loss. Although, fire is a natural phenomenon in the savanna, it is steadily entering the rainforest. Indiscriminate hunting of wildlife for food to complement subsistence farming and bush burning leads to loss of biodiversity and also depletes the ecosystem by causing death of wildlife; destruction of eggs and plant species, while illegal grazing of livestock in game reserves constitutes a threat to wildlife itself.

Cultural practices that encourage the use of specific species for festivals often limit the population of species particularly occurring under narrow ecological range. Moreover, most of the laws that control the management of several species are outdated and their enforcement is inadequate. The consequence is over exploitation of resources and subsequent loss of biodiversity. Direct causes of biodiversity loss are related to agricultural activities, bush burning, fuel-wood collection, logging, grazing and gathering. The introduction of cash crops like cocoa, coffee, rubber, cotton, groundnut and oil palm into the farming systems since the 1900s was a big impetus for massive deforestation of the natural ecosystems. The massive rate of deforestation is a direct cause of biodiversity loss.

## Conclusion:-

This paper presented some opportunities and challenges in conservation and use of medicinal and aromatic plants (MAPs) in Nigeria. Several recommendations and suggestions were made to counteract the challenges and promote conservation of the MAPs. It is very important to channel efforts and energy in conservation of plant resources, not just with the thought of preserving nature's bounty, but for the well-being and livelihoods of indigenous local communities and the society at large, who depend on these resources. Although conservation bodies exist, but more efforts are required in taking government policies and conservation strategies to rural dwellers and local communities. Government, non-governmental organizations, business and academic communities, research and tertiary institutions as well as students are enjoined to adopt proactive measures and employ education, knowledge and other recommendations suggested herein in the sustenance and conservation of medicinal and aromatic plants in Nigeria. It is therefore imperative to conserve our cultural heritage by scientifically evaluating the biological activities of the medicinal plants. It is also important to encourage the populace to practice the cultivation of these plants because most of the MAPs are collected from the wild, and the wild species are facing other negative consequences.

**Recommendations**

The following are recommended for consideration of the conservation of MAPs (Mamedov 2012):
Each medicinal plant has hundreds of biologically active chemical compounds that work synergistically together. This is a direct result of natural selection process of the the plant as a whole, not only identified main ingredient that might possess medicinal value.

Each medicinal plant has direct and indirect impact on human body. Direct impact is based on pharmacological action of its biologically active compounds. Indirect impact is related to interaction with other plants or drugs taken. Search for medicinal plants to cure epidemic diseases should include the plants from the geographical place, where these diseases were originated and most spread around. The disease may be existing there for thousands of years, and local healers/herbalists might cure or at least control spread of disease with native medicinal plants.

If one plant from one particular genus has significant medical value, all other plants from the same genus may have the same medical value. The only difference is potency; other plants from the genus may have more or less potency. When there is an investigation of essential oil plants, one should consider that essential oil content depends on the altitude. Essential oil plants from higher altitudes (as alpine grasslands) have higher content of essential oils.

Correct identification of medicinal plants by voucher specimen in herbarium is very important. Chemotaxonomy and molecular biology are helpful for plant identification. However, identification of chemical compounds and genetic markers alone is not enough, therefore, it must be complemented by classical botanical methods and botanical microscopy.

Evolutionary approach should be taken into used plants from one traditional herbal medicine system (Chinese, African, Indian, Western etc.), and then those plants should remain the first choice for treatment. Sustainable harvesting and deliberate cultivation have been proposed to ensure continued supply of medicinal plants to meet the health care needs of rural dwellers. Many types of action can be taken in favour of the conservation and sustainable use of medicinal plants. Some of these are undertaken directly at the places where the plants are found, while others are less direct, such as those relating to commercial systems, *ex situ* conservation and bioprospecting (Hamilton, 2004). Sustainable practice of traditional medicine and supply of plant materials for drug development are hinged heavily on deliberate and concerted efforts to conserve indigenous medicinal and aromatic plants (Oladele et al. 2011). According to Shingu (2005), sustainable use of medicinal plants means the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of the resource. Shingu (2005) also stated that sustainability and ownership issues are very pertinent if plants used in botanical medicine are to be meaningfully integrated, translated and applied to the traditional populations that that use them. He maintained that use of a species is likely to be sustainable if:

1. It is compatible with maintaining the ecosystem in which the species is found;
2. It does not reduce the future use potential and impair the long-term viability of the species; and
3. It does not reduce its future usefulness to humans.

Increased research and development of medicinal plants is also another recommendation for the conservation of medicinal plants. According to Shingu (2005), in order to improve on the general acceptability and sustainable use of botanical medicines and provide some scientific validity, much research and development (R&D) work is needed to standardize the nomenclature, collection, extraction, processing, formulation procedures, quality, safety, dosage, indications, contra-indications, etc.

Establishment of medicinal plant conservation centres in Nigeria is another recommendation. Bhattacharyya et al. (2006) stated that various programmes and strategies have been adopted and employed as well as establishment of medicinal plant conservation centres in India as in many other countries as a strategy for the conservation of medicinal plants.

Documentation and digitization of information on medicinal plants have also been recommended by various researchers as a means of conserving medicinal plants. According to Bhattacharyya et al. (2006), digitisation of information, i.e. development of electronic databases, is necessary in the study of medicinal plants for thorough understanding of important genetic resources. According to Shingu (2005), proper and careful scientific documentation will ensure successful exploitation and conservation of the medicinal plants. Adequate pharmacopoeia information should be developed to replace the traditional method of knowledge transfer. There

should be monographs of each medicinal plant that should be upgraded periodically. There is need to strengthen the information network on medicinal plants for their conservation. There is need for national databases on medicinal plants and for these to link up with other international efforts. Kankara et al. (2015) recommended scientific validation of biological properties of the medicinal plants as well as cultivation of medicinal plants to minimize the pressure on wild species.

Many species of medicinal and aromatic plants (MAPs) are cultivated for industrial uses, but most are still wildly collected. The need for renewable sources of industrial products as well as the need to protect plant biodiversity creates an opportunity for farmers to produce such crops. Amujoyegbe et al. (2012) recommended protection of wild species *in-situ*, cultivation in botanical gardens, general cultivation and inclusion of medicinal plants in cropping systems, collection of germplasm for establishment of germplasm banks, public information campaigns and others. Ideally, all medicinal plants species should be conserved as evolving populations in nature. However, these species should be conserved *ex situ* (i.e. outside their habitat) as well. Okigbo et al. (2008) recommended that effective conservation strategy for medicinal plants should take place within four main areas: *in-situ* conservation, *ex-situ* conservation, education and research. *In-situ* conversation involves protection and establishment of plants and other biological resources in the location of their natural occurrence. *Ex-situ* involves establishment of plantations, maintenance of living collections in farm fields, home gardens, botanical gardens, and other locations outside the zone of their natural occurrence.

In terms of education and training of TMPs, Shingu (2005) recommended a focus on the development of the right caliber of manpower for botanical medicine at all levels. A formal training programme should be designed to replace the hereditary mode of knowledge transfer. Such training may be organized through relevant government institutions or non-government organizations. It is necessary to organize a forum for exchange of information and to dialogue with traditional medical practitioners on a routine basis. This may be in the form of workshops, seminars or courses to educate the traditional healers on some important aspects of their practice.

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