REVIEW ON MEDICINAL PLANTS

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Abstract: Medicinal plants have been of existence from time immemorial. Over 250,000 exist and are believed to have different medicinal activities. Moreover, only the activities of about 50,000 plants have been examined. The use of plants for the remedy of diseases is usually termed phytotherapy, complementary and alternative medicine or phytomedicine. These plants have been classified based on part used, habit, habitat, therapeutic value, Ayurvedic formulations in which they are used and Botanical classification. Plant phytochemicals confer medicinal plants their medicinal activities and has been broadly classified into primary constituents which include the common sugars, amino acids, chlorophylls, proteins, purines and pyrimidines of nucleic acids etc. while secondary constituents are the remaining plant chemicals such as alkaloids, terpenes, flavonoids, lignans, plant steroids, curcumines, saponins, phenolics, flavonoids and glucosides. The activity of the phytochemicals depends on their structures. Several methods of extraction of this useful phytochemicals exists depending on the target phytochemical. Medicinal plants have shown promising antimicrobial activities, anti-helminthic, anticancer, antidiarrheal and antiviral activities. Phytotherapy have several advantages over synthetic drugs. Moreover, it also has limitations. The characteristics, advantages, limitations of phytotherapy is been reviewed in this work.

Keywords— Phytotherapy, solvents, phytochemical, medicinal plants, phytomedicine, herbalism, antimicrobial.

Introduction

The uses of plants as a source of remedy have been dated to times immemorial even to the first existence of man where the creator provided man for the purpose of food and herbs. (The KJV Holy Bible, 1979). The term medicinal plants include various types of plants used in herbalism and some of these plants have medicinal activities. (Bassam, 2012)

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These medicinal plants are considered as rich resources of ingredients which can be used in drug development and synthesis. Today, the use of plants for the remedy of diseases is usually termed Phytotherapy, complementary and alternative medicine or Phytomedicine. Complementary and alternative medicine (CAM) is a group of diverse medical and health care system, practices and products that are not presently considered to be part of conventional medicine. Complementary medicine is used together with conventional medicine. Conventional

Nigerian Journal of Microbiology 2015, 29: 3167-3183
Published online at www.nsmjournal.org

medicine is medicine as practiced by holders of M.D (medical doctor) or D.O (doctor of osteophathy) degrees and by their allied health professional, such as physical therapists, psychologist, and registered nurses (Saxon *et al.*, 2004). Example of CAM therapies are acupuncture, chiropractic and herbal medicines (Vickers, 2004). Traditional medicine refers to health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral based medicines, spiritual therapies, manual techniques and exercises applied singularly or in combination to treat, diagnose and prevent illness or maintain well-being (Berga *et al.*, 2003). Phytotherapy is a medical practice which uses plants resources or materials, in the diagnosis and treatment of ailment or illness, or as herbal remedies; in some ways, phytotheraphy can be thought of as a branch of nutrition since phytochemicals the bioactive component of herbs are now well accepted as being nutrient accessories (Walker, 1996).

The Use of Herbs as Medicine

Herbalism is a traditional or folk medicine practice based on the use of plants and plant extracts. Many of the herbs and spices used by humans to season food yield useful medicinal compounds (Lai, 2004: Okorondu *et al.*, 2006: Okigbo and Igwe, 2007). Many of the pharmaceuticals currently available to physicians have a long history of use as herbal remedies including opium, aspirin, digitalis and quinine, (Dobrin, 2006). At least 7,000 medical compounds in the modern pharmacopoeia are derived from plants, including ingredients in heart drugs, anticancer agents, hormones, ulcer treatments and decongestants. For example, Reserpine, extracted from ser-pent root, and *Rauvolfia serpentina* are used for lowering blood pressure and as tranquilizer and in India as a treatment for snake bite (Cowan, 1999). L-Dopa, from a tropical legume *Mucuna dearingiana*, used for treating Parkinson's disease, Ephedrine, a decongestant derived from the Chinese shrub *Ephera sinica* and Picrotoxin from *Anamirta cocculus* used as nervous system stimulant are examples of medicinal plants (Lietara, 1992).

Anthropologists theorize that animals evolved a tendency to seek out bitter plant parts in response to illness (Huffmann, 2003). Lowland Gorillas take 90% of their diet from the fruits of *Afromomum melegueta*, a relative of the ginger plant that is a potent antimicrobial and apparently keeps *Shigellosis* and similar infections at bay (Cindy and Houghton, 2002). Researchers from Ohio Wesleyan University found that some birds select nesting material rich in antimicrobial agents which protect their young from harmful bacteria. Also, sick animals tend to forage plants rich in secondary metabolites, such as tannins and alkaloids (Hutchings *et al.*, 2003), since these phytochemical often have antiviral, antibacterial, antifungal and antihelminthic properties; a plausible case can be made for self-medication by animals in the wild (Cindy and Houghton, 2002).

Phytomedicine

According to the World Health Organization (WHO, 2001), phytomedicine is defined as herbal preparations produced by subjecting

plant materials to extraction, fractionation, purification, concentration or other physical or biological processes. These preparations may be produced for immediate consumption or as the basis for other herbal products. Such plant products may contain recipient or inert ingredients, in addition to the active ingredients.

Characteristics of Phytomedicine

Phytomedicine has some characteristics that make them unique and different from synthetic drugs (Calixo, 2000).

- The active principle is frequently unknown
- The availability and quality control are often problematic
- Standardization, stability and quality control are feasible but not easy
- They have a wide range of therapeutic use and are suitable for chronic treatments.
- Well-controlled double blind clinical and toxicological studies to prove their efficacy and safety are rare when compared with synthetic drugs but well controlled randomized clinical trials revealed they do exist.
- They are cheaper than synthetic drugs.

Why the Demand for Phytomedicine

For years, public interest has increased for natural therapies (mainly phytomedicine) all over the world including Africa (Blumenthal, 1999; Roberts *et al.*, 1996; Grunwald, 1995). According to (Calixo, 2000 and Grunwald, 1995) there are several factors that leads to the preference and growth of phytotherapeutic market worldwide and they include:

- Preference of consumers for natural therapies
- Great interest in alternative medicine
- The belief that phytomedicine devoid of side effect since millions of people all over the world have been using phytomedicine thousands of years.
- The belief that phytomedicine is used for the treatment of certain diseases where conventional medicine fails.
- Improvement in the quality, proof efficacy and safety of phytomedicine and
- High cost of synthetic drugs.

Classification of medicinal plants

Of the 250,000 higher plant species on earth, more than 80,000 species are reported to have some medicinal value and around 5000 species have specific therapeutic value (Joy et al., 1998). They are classified according to the part used, habit, habitat, therapeutic value etc, besides the usual botanical classification as shown in table 1.

Phytochemicals of medicinal plants

The medicinal capacity of medicinal plants are usually attributed to the presence of certain secondary metabolites known as phytochemicals which have biological activities such as antioxidant activity, antimicrobial effect, modulation of detoxification enzymes, stimulation of the immune system, decrease of platelet aggregation and modulation of hormone metabolism and anticancer property. There are more than thousand known and many unknown phytochemicals. It is well-known that plants produce these chemicals to protect themselves, but

recent researches demonstrate that many phytochemicals can also protect human against diseases (Narasinga, 2003)

Phytochemicals (from the Greek word phyto, meaning plant) are biologically active, naturally occurring chemical compounds found in plants, which provide health benefits for humans further than those attributed to macronutrients and micronutrients(Hasler and Blumberg, 1999). More than 4,000 phytochemicals have been cataloged and are classified by protective function, physical characteristics and chemical characteristics (Meagher and Thomson, 1999). Phytochemicals accumulate in different parts of the plants, such as in the roots, stems, leaves, flowers, fruits or seeds (Costa et al., 1999; Okwu, 2005).

The exact classification of phytochemicals is not easily achieved due to their vast abundance. However, phytochemicals are classified as primary or secondary constituents, depending on their role in plant metabolism. Primary constituents include the common sugars, amino acids, chlorophylls, proteins, purines and pyrimidines of nucleic acids etc. Secondary constituents are the remaining plant chemicals such as alkaloids, terpenes, flavonoids, lignans, plant steroids, curcumines, saponins, phenolics, flavonoids and glucosides (Hahn, 1998). From reviews, it has been discovered that phenolics are the most numerous and structurally diverse plant phytochemicals as seen in figure 1.

Each phytochemical have distinct chemical structure and physiochemical activity and also the activity of each phtochemical is dependent on the structure of the phytochemical. (Mamta *et al.*, 2013). The medicinal activities of the different classes of phytochemicals have been reviewed recently. A review of biological activities of medicinal plants is seen in table 2. (Mamta *et al.*, 2013; Prashant, 2011). Phytochemicals are diverse and also vary in amounts in different parts of plants. Amin *et al.*, 2013, analysed the phytochemicals in different parts of a medicinal plant-*Taraxacum officinale* (stem, flower and root), the flower yielded the highest percentage of extract using different solvents. The phytochemicals also differs in different stages of maturity (Irondi *et al.*, 2013).

Solvent methods of extraction in phytotherapy

Most of the phytomedicines and drugs employed for the treatment of human ailments are obtained by extraction either by infusion or decoction process using water, natural gin or palm wine as solvent. Some drug registration bodies like the food and drug administration and control of the U.S.A, require information on the structure(s) of the active agents in plant drugs before it can be approved for administration hence, correct selection of solvents and methods of extraction are essential in the study of activity of plant constituents or active ingredients, (Unaeze and Abarikwu, 1986). There is the need for careful choice of solvent for extraction of bioactive principle of medicinal plants as most organic solvents are toxic and lethal, thus leading to as biased view of the efficacy of the plant extract as to whether the microbial inhibition was due to the bioactive ingredient or toxicity of the solvent for extraction; Grape fruit seed extract is an example as multiple studies

demonstrate its universal antimicrobial effect is due to synthetic antimicrobial contamination, (Takeoka *et al.*, 2001). Alternative medicine using such plant extracts leads to an undesired side-effect in the patient.

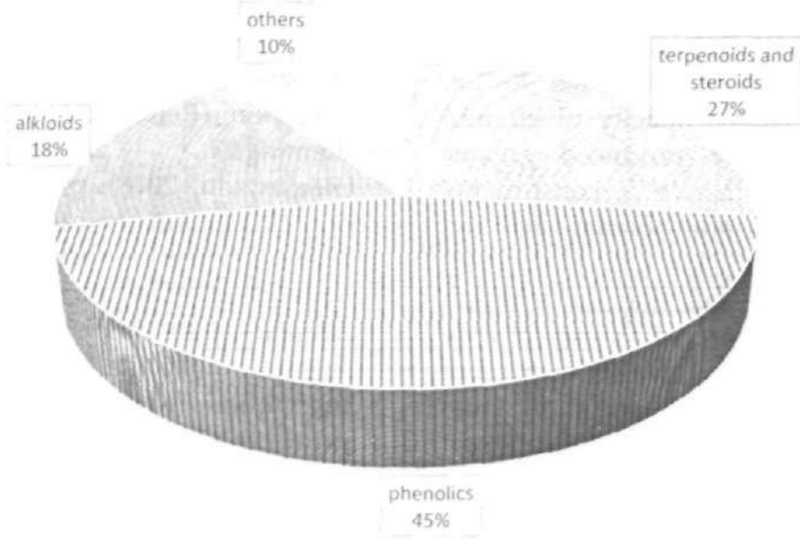

Figure 1: Major group of phytochemicals and their abundance Modified from Mamta et al., 2013.

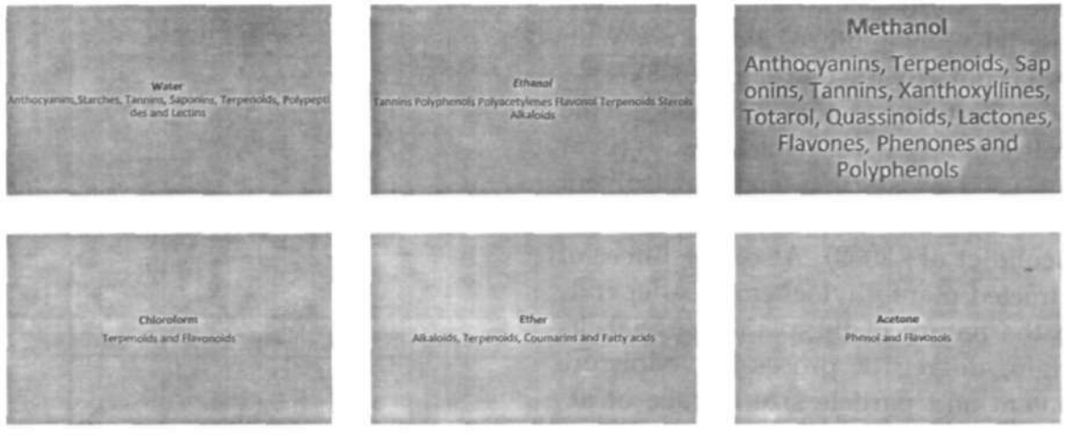

Figure 2: different solvents used for extraction and their target phytochemical Modified from Cowan, 1999.

Common solvents used in extraction of bioactive plant ingredients include; ethanol, water, methanol, chloroform, phenol, ethyl acetate, dichloromethane, hexane etc. it has been observed that the ethanol extract exerted greater antibacterial activity than corresponding water extracts; these observation may be attributed to the stronger extraction capacity of ethanol which could have produced greater number of active constituents responsible for antibacterial activity, (Kabir *et al.*, 2005; Okorondu *et al.*, 2006, 2009a,b). This reveals that the strength of medicinal potency of an extract may be dependent on the solvent method of extraction. Cowan (1999) show that different solvents extract different phytochemicals as shown in figure 2.

According to Prashant (2011), Extraction methods used pharmaceutically involves the separation of medicinally active portions of plant tissues from the inactive/inert components by using selective solvents. During extraction, solvents diffuse into the solid plant material and solubilize compounds with similar polarity (Ncube et al., 2008).

Certain factors influence the quality of an extract. This includes plant part used as starting material, solvent used for extraction and procedure. (Ncube et al., 2008). Also, the Effect of extracted plant phytochemicals depends on the nature of the plant material, its origin, degree of processing; Moisture content and particle size (Ncube et al., 2008). The variations in different extraction methods that will affect quantity and secondary metabolite composition of an extract depends upon type of extraction, time of extraction, temperature, nature of solvent, solvent concentration and polarity (Ncube et al., 2008).

The process of extraction varies depending on the target phytochemical (Prashant *et al.*, 2011) which include plant tissue homogenization (Das et al., 2010), serial exhaustive extraction, soxhlet extraction (Nikhal et al., 2010), maceration (Ncube et al., 2008), decoction (Remington, 2006), infusion (Remington, 2006), digestion (Remington, 2006), percolation (Handa et al., 2008) and sonication (Handa et al., 2008). For aromatic plants, hydrodistillation techniques (water distillation, steam distillation, water and steam distillation), hydrolytic maceration followed by distillation, expression and enfl eurage (cold fat extraction) may be employed. Some of the latest extraction methods for aromatic plants include headspace trapping, solid phase micro-extraction, protoplast extraction, microdistillation, thermomicrodistillation and molecular distillation (Handa et al., 2008).

Table 1: Classification of Medicinal Plants

CLASSIFICATION	EXAMPLES
Based on part used	Whole plant *(Boerhaavia diffusa)*, Root *(Dasamula)*, Stem*(Tinospora cordifolia*, Bark *(Saraca asoca)*, Leaf*(Indigofera tinctoria, Aloe vera)*, Flower *(Biophytum sensityvum)*, Fruit *(Solanum species)* and Seed *(Datura stramonium)*.
Based on habit	Grasses *(Cynodon dactylon)*, Sedges *(Cyperus rotundus)*, Herbs *(Vernonia cineria)*, Shrubs *(Solanum species)*, Climbers *(Asparagus racemosus)* and Trees *(Azadirachta indica)*
Based on habitat	Tropical *(Andrographis paniculata)*, Sub-tropical: *(Mentha arvensis)* and Temperate (*Atropa belladonna)*.
Based on therapeutic value	Antimalarial *(Cinchona officinalis)*, Anticancer *(Catharanthus roseus)*, Antiulcer *(Azadirachta indica)*, Antidiabetic *(Catharanthus roseus)*, Anticholesterol *(Allium sativum)*, Anti-inflammatory *(Curcuma domestica)*, Antiviral *(Acacia catechu)*, Antibacterial *(Plumbago indica)*, Antifungal *(Allium sativum)*, Antiprotozoal *(Ailanthus sp.)*, Antidiarrhoeal *(Psidium gujava)* Hypotensive *(Coleus forskohlii)*, Tranquilizing *(Rauvolfia serpentine)*, Anaesthetic *(Erythroxylum coca)*, Spasmolytic *(Atropa belladonna)*, Diuretic *(Phyllanthus niruri)*, Astringent *(Piper betle)*, Anthelmentic *(Quisqualis indica)*, Cardiotonic *(Digitalis sp.)*, Antiallergic *(Nandina domestica)* and Hepatoprotective *(Silybum marianum)*.
Based on Ayurvedic formulations in which used	a) The ten roots of the Dasamoola (*Dasamoolam*) *Desmodium gangeticum (Orila), Uraria lagopoides (Cheria orila), Solanum jacquinii (Kantakari), Solanum indicum (Cheruchunda), Tribulus terrestris (Njerinjil), Aegle marmelos (Koovalam), Oroxylum indicum (Palakapayyani), Gmelina arborea (Kumizhu), Steriospermum suaveolens (Pathiri) and Premna spinosus (Munja)* b) The ten flowers of the Dasapushpa (*Dasapushpam*) *Biophytum sensitivum (Mukkutti), Ipomea maxima (Thiruthali), Eclipta prostrata (Kayyuniam), Vernonia cineria (Poovamkurunnil), Evolvulus alsinoides (Vishnukranthi), Cynodon dactylon (Karuka) Emelia sonchifolia (Muyalcheviyan) Curculigo orchioides (Nilappana) Cardiospermum halicacabum (Uzhinja) and Aerva lanata (Cherula)* c) The four trees of the Nalpamara (*Nalpamaram*) *Ficus racemosa (Athi), Ficus microcarpa (Ithi), Ficus relegiosa (Arayal) and Ficus benghalensis (Peral)* d) The three fruits of the Triphala (*Thriphalam*) *Phyllanthus emblica (Nellikka), Terminalia bellerica (Thannikka) and Terminalia chebula (Kadukka)*
Botanical classification	This is the most comprehensive and scientific classification. The various medicinal plants are grouped according to their Class, Series, Order, Family, Genus and Species.(Dey, 1984)

Modified from Joy *et al.*, 1998

Table 2: Mechanism of action of some phytochemicals

PHYTOCHEMICALS	ACTIVITY	MECHANISM OF ACTION
Quinones	Antimicrobial	Binds to adhesins, complex with cell wall, inactivates enzymes
Flavonoids	Antioxidants	Oxygen free radical quenching, inhibition of lipid peroxidation
	Antimicrobial	Complex with cell wall, binds to adhesions
	Antidiarrhoeal	Inhibits release of autocoids and prostaglandins, Inhibits contractions caused by spasmogens, Stimulates normalization of the deranged water transport across the mucosal cells, Inhibits GI release of acetylcholine
	Anticancer	Inhibitors of tumor, inhibited development of lung cancer, anti-metastatic activity
Polyphenols and Tannins	Antimicrobial	Binds to adhesins, enzyme inhibition, substrate deprivation, complex with cell wall, membrane disruption, metal ion complexation
	Antidiarrhoeal	Makes intestinal mucosa more resistant and reduces secretion, stimulates normalization of deranged water transport across the mucosal cells and reduction of the intestinal transit, blocks the binding of B subunit of heat-labile enterotoxin to GM_1, resulting in the suppression of heat-labile enterotoxin-induced diarrhea, astringent action
	Anthelmintic	Increases supply of digestible proteins by animals by forming protein complexes in rumen, interferes with energy generation by uncoupling oxidative phosphorylation, causes a decrease in G.I. metabolism
	Antioxidants	Oxygen free radical quenching, inhibition of lipid peroxidation
	Anticancer	Inhibitors of tumor, inhibited development of lung cancer, anti-metastatic activity, and cancer chemoprevention
Coumarins	Antiviral	Interaction with eucaryotic DNA
	Detoxifying Agents	Inhibitors of procarcinogen activation, inducers of drug binding of carcinogens and inhibitors of tumourogenesis
Terpenoids and essential oils	Antimicrobial	Membrane disruption
	Antidiarrhoeal	Inhibits release of autocoids and prostaglandins
Alkaloids	Antimicrobial	Intercalates into cell wall and DNA of parasites, Inhibits release of autocoids and prostaglandins
	Antidiarrhoeal	Possess anti-oxidating effects, thus reduces nitrate generation which is useful for protein synthesis, suppresses transfer of sucrose from stomach to small intestine, Neuropharmacological agents.
	Anthelmintic	diminishing the support of glucose to the helminthes, acts on CNS causing paralysis
Lectins and Polypeptides	Antiviral	Blocks viral fusion or adsorption, forms disulfide bridges

Glycosides	Antidiarrhoeal	Inhibits release of autocoids and prostaglandins
Saponins	Antidiarrhoeal	Inhibits histamine release in vitro
	Anticancer	Possesses membrane permeabilizing properties
	Anthelmintic	Leads to vacuolization and disintegration of teguments
Steroids	Antidiarrhoeal	Enhance intestinal absorption of Na^+ and water
Carotenoids	Antioxidants	Oxygen free radical quenching, inhibition of lipid peroxidation
	Detoxifying Agents	Inhibitors of procarcinogen activation, inducers of drug binding of carcinogens and inhibitors of tumourogenesis
	Anticancer	Inhibitors of tumor, inhibited development of lung cancer, anti-metastatic activity
Tocopherols	Antioxidants	Oxygen free radical quenching, inhibition of lipid peroxidation
	Detoxifying Agents	Inhibitors of procarcinogen activation, inducers of drug binding of carcinogens and inhibitors of tumourogenesis

Culled from Prashant (2011) and Mamta, 2013

Benefits of phytomedicine

Therapeutic Benefit of Phytomedicine over Synthetic Drugs

Although synthetic or chemical drugs can have greater or quicker effects than do equivalent phytomedicine, they present a higher degree of side effects and risks. For instance, psychopharmacological products with sedative and axiolytic action are likely to be accompanied by undesirable side effects like uncoordinated motor skills and drowsiness, but phytomedicine acts on the body by regulating and balancing its vital processes rather than stopping or combating certain symptoms. Its balancing effect on the CNS prevents disorders and unbalanced mental condition (Pamplona-Roger, 1999). Phytomedicines are of great benefit for the respiratory systems since their action are not limited to neutralizing the symptoms of any disease but they exert a true cleansing action for excessive mucus in the interior of the airway. They contain certain antibiotic substances that prevent bacteria growth in the mucus, for example *Thymus vulgaris* (thyme), allium sativum (garlic). Phytomedicines have a wide range of therapeutic use and are suitable for chronic treatments (Calixo, 2000). They are said to be gentle, effective and often specific in function to organs or systems of the body (Iwu *et al.*, 1999). Plants like *Cimicifuga racemosa* (black cohosh), *Augelica sinensis* (Don quai) and *Agmis castus* (Cahste tree berry) have been reported to be specifically useful for premenstrual syndrome, PMS (excessive estrogen) as recorded by Schellenburg, 2001 and Wuttke, 2000. Phytomedicine are good dietary supplements, which are nutritive and can replenish the body. For example, sunflower seed (*Helianthus annus*) provides vitamin B_6 (Pyridoxine) as reported by MacDougall, (2000). Phytomedicines are effective in the treatment of infectious diseases as well as limit side effects associated with synthetic antimicrobial drugs. Plants like *Ancistrocladus abbreviatus* from Cameroon has been reported to show a strong anti-HIV activity due to michellamine B and has been developed for treating people living with HIV/AIDS (Sofowora, 1993.) Antimicrobial activities of phytomedicine which are effective in curing infectious human pathogens like *E.coli, Candida albicans, Staphylococcus aureus, Bacillus* spp etc has been investigated by Iwu *et al.*, 1999; Okigbo and Nmeka, 2005; Boakye-Yiadom *et al.*, 1997; Sawer *et al.*, 1995; Okorondu *et al.*, 2010a,b,c and 2013. The actions of phytomedicine often extend beyond symptomatic treatment of diseases (Iwu *et al.*, 1999); for example, *Hydrastis canadensis* not only has antimicrobial properties but also promotes optimal activity of the spleen in releasing compounds by increasing the blood flow in the spleens as reported by Murray, 1995. Finally, they are usually less expensive than synthetic drugs (Calixto, 2000).

Economic Benefits

The interest in natural therapies has increased international trade in phytomedicine and attracted most pharmaceutical companies interested in commercializing phytomedicines as recorded by Calixto, (2000). The production, processing and sale of phytomedicine products create employment for the producing countries (Gunasena and Hughes, 2000). According to Calixto, (2000) and

Blumenthal (1999), the European market alone reached $7 billions in 1997; the German market corresponds to about 50% of the European market, about $3.5 billion which represents about $42.90 per capita; the market in France corresponds to about $1.8 billion, Italy follows with $700 million, UK has $400 million, Spain and Netherlands have market sales of $300 million and $100 million respectively. The U.S phytomedicine trade reached $3.2 billion in 1996 and 5 billion in 1999 (Blumenthal, 1999 and Roberts *et al.*, 1996). Grunwald (1995) reported that markets in Asia and Japan reached $2.3 billion and 2.1 billion respectively. Over $2.4 billion worth of traditional Chinese medicines (TCM) were sold and $400 million worth of TCM were exported out of China in 1993, about $60 million was realized from herbs in 1996 in Malaysia, in Europe, North America and Africa, about 75% of people living with HIV/AIDS patronize complementary and alternative medicine. As a whole the annual market value of phytomedicine is close to $43 billion (more than some African annual budgets) as reported by Elujoba *et al* (2005) and Enwonwu, (2003). Anti-infective agents make up 24% of the pharmaceutical market (1992 Census of Manufacturers, United States (1994). An antimicrobial, *Hydrastis*, has a sale of 4.7% in 1995. Hypercium perforatum (St. John's wort), an antiviral and antidepressant had increased in sales to over 20,000% in the mass market sector in 1997 (Aarts, 1998). About 75% of the population of France has used complementary/ alternative medicine at least once (Enwonwu, 2003) and about 60 million Americans over 18 years use phytomedicine in the cure of colds, burns, headaches, depression, diarrhea and others (Calixto, 2000).

Challenges in the Use and Development of Phytomedicine

There are many factors hindering the development of phytomedicine in Africa and these problems have to be fully addressed so as to move the African Health Agenda forward. Such problems include:

- Development of drug from its natural sources is not an easy task and is more difficult than synthetic drug development; formulation of phytomedicine particularly in crude-drug form requires a specialized expert area that requires training and experience (Elujoba *et al.*, 2005)
- Lack of standardization and quality control of the herbal drugs used in clinical trials (Calixto, 2000) and occult practices.
- The risk of side effect due to toxicity, over-dosage, interaction with conventional drugs as recorded by Calixto, (2000), Ernst, (1999), and several manufacturing problems such as misidentification of plants (Calixto, 2000), lack of standardization, failure of good manufacturing practice, contamination as a result of field microbial contamination, poor packaging chemical used, the environmental condition (temperature, light exposure) (Elujoba *et al.*, 2005 and Calixto, 2000), substitution and adulteration of plants, incorrect preparation and dosage (Calixto, 2000).
- Imprecise diagnosis and dosage for phytomedicine (Calixto, 2000; Boakye-Yiadom, 1979)
- There is lack of collaborative research among TMP's, Orthodox medical practitioners and scientists Elujoba *et al.*, 2005; Makhubu, 2006). As a result, there is a danger of losing valuable ethnomedical knowledge that the TMPs have concerning the plant and other

aspects of the medicinal system that are intrinsically part of their lives (Makhubu, 2006).

- Inadequate randomizations in most studies, patients are not properly selected and the numbers of patients used in most trials are insufficient for the attachment of statistical significance (Calixto, 2000).
- Problem of serious attention, energy, resource mobilization commitment and the required political will (Elujoba *et al.*, 2005).
- Communication problem is an obstacle between the TMPs and the scientists (Makhubu, 2006)
- There is wide variation in the duration of treatment using herbal medicine (Calixto, 2000)
- Domestication: it is difficult to convince members of a community to trust phytomedicine after a long use of Orthodox medicine, as assessed by Makhubu, (2006).
- There is absence or inadequate record of what is available and many species are becoming extinct because they are not cultivated and protected from indiscriminate harvesting (Ernst, 1999; Elujoba, 2003). Also, the traditional healers are of advancing age and dying (Elujoba, 2003).
- Unfavourable legislation such as witchcraft act of 1901 (Makhubu, 2006).

Possible Solutions

The quality and stability of phytomedicine is achieved by the use of fresh plants, regulated physical factors like temperature, light, water availability, cultivation of plants in place of wild-harvested plants, because they show smaller variation in their constituents. The standardization of phytomedicine can also be achieved by the use of chromatography, infrared and ultraviolet (UV) spectrometry (Calixto, 2000).

The African pharmacognosists, pharmacologists, pharmacists, physicians have to learn, acquire, document and use traditional medicine to help curtail the extinction of plants and human resources (Elujoba, 2003). Workshops with TMPs have to be conducted to break the communication problem between the TMPs and scientists, and human resources can be obtained through individual contacts (Makhubu, 2006). Collaborative work could be achieved through staff exchange and training and funding for capital building; the government should help in funding researches on phytomedicine; the private sector as well as non-government should help in funding researches on phytomedicine; the private sector as well as non-governmental agencies should also help finance researches; organization of seminars to raise awareness to the general public on the benefits of medicinal plants and also remove the perception that scientists are out to harness their knowledge for money making, abandoning outdated legislation such as witchcraft act, (1901) and passing new legislation to protect indigenous traditional knowledge and for the integration of traditional medicine into the health scheme (Makhubu, 2006).

Future Suggestions on the Development of Phytomedicine in Africa

As medicinal plants are going global with increasing demand in the phytotherapeutic market, some factors have to be put in mind in order to meet the world herbal medicine's standard of safety and efficacy. The following

factors must be emphasized in Africa for the development of phytomedicine.

- Emphasis on well-controlled and randomized clinical trials to prove the safety and efficacy of herbal medicine. With the growth of the botanical market, the quality, efficacy and safety of phytomedicine used clinical trials have to be improved so as to produce standardized drugs (Calixto, 2000). Researchers on traditional medicine should be made to develop novel therapeutic methods.
- An improvement in the process of regulation and global harmonization of phytomedicine. The integration of Africa traditional medicine into the health system should be in a way to bring harmony between traditional and modern system of health care with minimum threat to each other (Elujoba *et al.*, 2005; Calixto, 2000).
- Greater emphasis should be placed on collaboration work with TMPs and other scientists in order to bring traditional healers closer to scientists by engaging healers in laboratory work, training them as well as get information on traditional prescriptions for specific diseases (Makhubu, 2006).
- Emphasis has to be placed on domestication, production, biotechnological studies and genetic improvement of medicinal plants. The domestication of plants will help in reducing effects associated with wild-harvested plants, avoid misidentification and field contamination. Increase the quality of raw materials and yield through genetic breeding and selection. Production of phytomedicine with resistance to microorganisms-induced diseases (Calixto, 2000).
- Detailed legislation on the ownership of intellectual property right has to be made (Calixto, 2000; Makhubu, 2006).

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