ETHNOBIOLOGY AND DEVELOPMENT: RELEVANCE OF TRADITIONAL KNOWLEDGE IN THE GROWTH OF NATURAL PRODUCTS INDUSTRY AND SUSTAINABLE ENVIRONMENTAL MANAGEMENT

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ABSTRACT
Traditional or indigenous communities have for a long time contributed to the accumulation of world knowledge. Unfortunately, in the context of modern science and technology this knowledge is largely ignored and undervalued. Recent approaches to development and industrialisation, however, are geared towards up-scaling traditional innovations, technologies and inventions. There are traditional practices especially in utilisation biological resources that are likely to contribute to acceleration of development of natural products industry and sustainable environmental management in the 21st century. These may include indigenous knowledge of local plants and forest products, knowledge on important species for integration in pest management, innovative ideas in ecological processes and land use. This paper explores the relevance of ethnobiological data in sustainable natural products industrial development and environmental management

Key words: Traditional knowledge, natural products commercialisation, environmental management

1.0 INTRODUCTION

Ethnobiology is a branch of study that deals with documentation of traditional/ indigenous uses of plants and animals as well as their associated preparations methods. In recent past however, the study also encompasses the study of the processes of cultivation, management and domestication of these biological resources. It is part of the wider ethnoscience (folk science) which includes other subsets such as: ethnoecology (ecological concepts and relationships held by a given people or culture), ethnobotany (the study of how human beings have utilised plants for a wide diversity of primary survival and aesthetic purposes, ethnopharmacology (scientific exploration of biologically active agents traditionally employed by man), traditional ecological knowledge (TEK) - experiences acquired over thousands of years of direct human contact with the environment.

Although many communities have utilised plant and animals for centuries, it's only recently that scientists are beginning to appreciate the importance of this knowledge in rural economies. When rural economies are linked to national and international markets, the value of the biodiversity formerly utilised for local consumption is expected to increase in value (Godoy and Bawa, 1993). A key component in ethnobiology which has not received sufficient scientific attention is the link between ethnobiology and economic development particularly in the discovery of wild biological resources that could be commercially exploited (Alcorn, 1995). For Kenya's biodiversity to have any meaningful impact on the socio-economic development, local communities and rural economies need to receive attention especially in benefit sharing arising from bioprospecting (Institute of Economic Affairs, 2009).

Traditional knowledge of various communities is relevant to development in the short and long term, especially because these communities manage genetically important plant and animal biodiversity which may be significant in solving complex problems being experienced in this century. The importance of this body of knowledge is best explained by the African proverb: 'when a knowledgeable old person dies, a whole library disappears' (Lalonde, 1993). This knowledge is orally passed from generation to generation, hence continuous disruption of cultural set-ups and younger people showing disinterest in learning local languages, traditional knowledge is on the verge of disappearance. The natural resources themselves, for example traditional medicinal plants, which may contribute greatly to trade in natural products in this century, are at risk due to habitat destruction and unsustainable rates of exploitation among other factors (World Bank, 1992).

Ethnobiologists have therefore gone a long way in securing traditional knowledge relevant for development by documentation and establishing innovative ways of integrating traditional and scientific knowledge systems for effective natural resource use and management. Research shows that integration of traditional knowledge into the market economy through economic activities based on utilisation of natural resources could accelerate the acquisition and use of traditional ecological knowledge (Guest, 2002). A study among the Tsimane, Amazon reveals that economic development that does not undermine traditional knowledge ends up contributing to preservation of traditional knowledge as well as community advancement (Reyes-García *et al*., 2007).

In order to survive, man has been engaged in the search for effective tools and instruments. With time and step-by-step this search has led to a build-up of usable technologies that preceded the development of science. Early man also observed consistencies in the patterns of natural phenomena and in this context discovered that some plants could be useful for food, be poisonous or posses healing properties (Figueiredo, 1996).

Present-day scientific and technological breakthroughs have borrowed heavily from inventions and innovations of traditional communities. Unfortunately because of the open access and transfer of knowledge that characterises traditional communities, modern scientific technologies developed from such knowledge base have not seen these communities rewarded. This calls for well negotiated intellectual property rights and benefit sharing when commercial products are developed by integration of traditional and modern scientific knowledge.

Failure to recognise, understand and use of indigenous knowledge has contributed to environmental degradation, loss of biodiversity, innovation and inventions in most African countries (Almquist *et al*., 1993). Local communities are known to be knowledgeable about local plants and other natural resources on which they are immediately and intimately dependent (Martin, 2004). The amount of traditional knowledge lost each year and means of salvaging and utilising the knowledge needs to be considered in industrial development.

In this century, there is renewed commercial interest in natural products. With recent advances in bio-processing technologies of plant material, it is estimated that a third of all industrial materials are of plant origin (RAFI, 1994). Majority of these plants are found in the biodiversity-rich countries such as tropical Africa including Kenya. Industrial interest in natural oils, medicines, emollients, demulcents, adhesives, latexes, gums, resins and herbal medicines that have been utilized by traditional communities for centuries. Their long use in traditional communities provides new opportunities for up scaling the value of these products. Higher success rates have been reported when indigenous knowledge is integrated in the process on bioprospecting activities than using random screening (Carlson, *et al*., 1997).

In this century, effects of mutant microorganisms resistant to drugs of choice as well as new diseases such as AIDs, viral infections and various types of cancers are expected to be on the increase. New drugs using traditional knowledge as a lead will be needed to tackle health problems (Lewis, 2003;Voeks, 2004).

Realisation of the significant role that traditional knowledge is likely to play in discovery of novel products has put traditional knowledge of biological resources on top of global development agenda. This can be reflected in various international, regional and national policies, including WHO traditional medicine strategy 2002-2005, Decade of the African traditional medicine African Unity (formerly OAU) 2001-2010 and Convention of Biological Diversity's (CBD) recognition of the need to respect, preserve and maintain knowledge and practices of traditional communities that are in favor of environmental protection. This paper explores the part traditional knowledge of biological resources in different communities has played and continues to play in development of the natural products industry as well as in sustainable environmental management.

Various mechanisms have been put in place to ensure intellectual property protection of local people's knowledge in commercialisation. Although the formal intellectual property rights systems are weak in protecting traditional knowledge and indigenous peoples, there are advances nationally and international towards having systems that prevent bio-piracy (unauthorised use of traditional knowledge or biological resources). The two main international conventions which protect the rights of traditional systems include THRIPS (World Trade Organisation's trade Related Aspects of intellectual property rights) and CBD (convention of biological diversity). It is however being felt that national laws are more important in achieving protection and practical benefits for traditional knowledge holders (Kartel, 2007). In Kenya several bills have been drafted towards having a national legal system of protecting traditional knowledge and innovations. These include; the proposed Traditional Medicine and Medicinal Plants Policy under the Ministry of Health, bill on Protection of Genetic Resources as well as the Traditional Knowledge and expression Folklore being developed by a Task Force under the Attorney General's Office (Institute of Economic Affairs, 2009).

2.0 TRADITIONAL KNOWLEDGE IN DRUG DISCOVERY AND DEVELOPMENT

Many drugs in clinical use today were discovered from the way plants and other biological resources were used in traditional communities. Plants especially have formed a part of traditional medicine systems dating many years; 2900 BC in Egypt; 100 AD among the Greeks; 1100 B.C. among the Chinese and about 1000 BC in the Indian Ayurvedic system (Gordon Newman, 2001).

Such drugs have been instrumental in alleviating global health problems. For instance quinine was discovered from the way traditional communities in S. America especially Peru, Columbia and Bolivia used plant species of the genus *Cinchona* in managing fevers (van Wyk *et al*., 2002). While quinine formed the basis for the synthesis of antimalarial drugs chloroquine and mefloquine, resistance of plasmodium to these drugs especially in the tropics led to investigation and discovery of artemisinin and its derivatives artemether and artether from the Chinese use of the plant *Artemisia annua* for management of fevers (Gordon and Newman, 2001). Digitoxin on the other hand is a popular heart tonic obtained from *Digitalis purpurea,* a plant that was in use as heart tonic in traditional communities in Europe. Taxol is a modern therapy for ovarian cancer obtained from *Taxus brevifolia* which was a medicinal plant in British Columbia (Farnsworth, 1990). Reserpine is an important hypotensive agent developed from *Rauwolfia* spp. which were part of the Indian Aryuvedic remedies, while Vinblastine and vincristine have been developed from *Cathanranthus roseus* which was part of traditional pharmacopoeia of Madagascar. Various species of Podophyllum were used early American and Asian cultures for treatment of skin cancers and warts. These plants have yielded the antitumor agent podophyllotoxin (Gordon and Newman, 2001).

Although alkaloids have been in human service for many years with morphine being the first commercial natural product in 1826, they continue to be of contemporary interest in present times (Cordel *et al*., 2001). Some of the alkaloids under investigation from ethnotherapeutics resources include Camptothecin, a potent antitumor agent

from the Chinese tree *Camptotheca acuminate*, epibatidine, an analgesic from the forest frog, *Epipedobates tricolor*, ibogaine, an anti-addictive agent from the West African ethnomedical plant *Tabernanthe iboga*, huperizines, especially huperizine A for memory enhancement and improvement of cognitive function obtained from club moss *Lycopodium serratum*, used in Chinese medicine for management of fevers and inflammation (Cordel *et al*., 2001).

So far, two thirds of the global medicinal plants are known to grow in tropical countries (Gasengayire, 2003), but only less than 90 species are well investigated for their pharmaceutical potential. Ethnopharmacological investigations however are gradually picking up with more and more plants in ethnomedicines being studied in various parts of the world. These have targeted search for drugs for important diseases such as malaria and tuberculosis. When activity is compared between plants used in ethnomedicine and those randomly selected the former revealed higher biological activity. The multi-species (many species combined in one preparation) methods used in traditional preparation of drugs are also found to be relevant in modern day drug discovery and development. This is foreseen to provide a way of producing multiple-compound pharmaceuticals which will provide longer protection against resistance (Lewis, 2003). A further aspect of relevance of ethnomedicines in future drug discovery in present and future is that for most traditional societies 'food is medicine and medicine is food' (Voeks, 2004). This connection of eating and healing is as old as the plant domestication process itself. This implies that as medicinal biological resources are domesticated as sources of medicines many of them will serve as nutritional sources as well.

Floristic studies have listed 5400 traditional medicinal plants taxa and over 16,300 medicinal uses in the African continent (Neuwinger, 2000). These plants are thought to play a major role in socio-economic development of the African continent, particularly in development of commercial natural products from them (van Wyk, 2008). Investigations regarding these plants need to be accelerated. In South Africa for example, 3000 species are known to be used traditionally as sources of medicines, but only 38 indigenous species have been commercialised, with modern well packaged products available in the market (van Wyk, 2008).

Although medicinal plants have in the past been a major component of health care delivery system in developing countries, the scenario is now changing and is likely to change in this and next century with demand in developed countries being on the increase (Robbins, 2000). The global trade in medicinal plants was estimated at US $ 800 million in 1995-96 (Lange, 1997), and is increasing at an annual rate of 7% (World Bank, 2004).

It is now estimated that the natural plants industry is the fastest growing sector in the entire agribusiness industry (Makunga *et al*., 2008). Conservative estimates show that the annual value of developing countries' germplasm to the pharmaceutical industry is about $47,000 million per year (RAFI, 1994).

With present demand for nutraceuticals and over-the-counter herbal-based drugs locally and abroad, it is expected that herbal remedies previously found in local communities as home remedies will feature prominently in the local and global market. In the United States of America and Europe, the use of plant-based pharmaceuticals

have increased exponentially, with botanical industry in USA earning $ 1.5 billion per year and European market three times as much (Robbins, 2000; Taylor *et al*., 2001). Estimates reveal that '30,000 American lives are saved each year by anti-cancer drugs derived from plants' (Voeks, 2004).While USA and Europe are leading in this market with 35% and 33% global market shares respectively, Africa only contributes about 1% of this (Makunga *et al*., 2008).

Advances have been made to integrate traditional uses of plants with modern day drug discovery and development in several African countries as an attempt to participate more in the growing natural products industry globally. In South Africa for example, several products previously used as home ethnomedical remedies have found their way in the commercial modern market. These include, but are not limited to the following: *Agathosma betulina* and *A. crenulata* species are locally referred to as 'Bachu' with many traditional uses but currently in natural products industry as sources of flavour and fragrance, while the oils are used in the manufacture of perfumes and colognes (Moolla & Viljoen, 2008). *Pelagornium sidoides* on the other hand has a rich ethnobotanical history but its commercial products are being exported to many countries outside S. Africa. A new product from this plant ('Umckaloabo') is fully licensed and had a turnover of about 80 million Euros in 2006 in the German market (Moolla & Viljoen, 2008). Perhaps the most popular and controversial ethnomedical plant from South Africa in our times is *Hoodia gordonii*. The plant was reported in ethnobotanical records as used by Khosan communities as thirst quenching and appetite-suppressant plant. Many appetite-suppressant agents, natural anti-obesity agents as well as *Hoodia*-containing commercial preparations are in the market (van Heerden, 2008). The income accrued from these sales is directly benefiting the local communities who already had knowledge of its value before the scientific validation in modern laboratories. Although many species in the genus Aloe are ethnographically important in South Africa, *Aloe vera* and *A. ferox* are species of ethnomedical significance that are now in commercial trade (Grace *et al.,* 2008).

Some medicinal plants documented from Kenya that are already involved in international trade include *Prunus africana* (exported mainly to France), *Cissus rotundifolia* (to France), *Ansellia africana* (to UK), *Dracaena fragrans* (Marshall, 1998). Since 1970, *Prunus africana* bark harvest has shifted from subsistence use to large-scale commercial use for international trade, with over 40 brand-name products marketed in about 10 countries (Cunningham, 2008). This plant whose bark was once harvested as a source of medicine for some remedies has now increased in value with over-the-counter sales averaging US$220 million annually, with substantial benefits to local communities in Kenya, Cameroon and other African countries.

Many ethnobotanical studies have been accomplished in Kenya with traditional uses of plants from the various communities being documented (Vickery & Vickery, 1976; Morgan, 1981; Ochoki, 1982; Heine & Heine, 1988; Waliaaula, 1988; Johns *et al*., 1990; Stilles & Kassam, 1991; Njoroge, 1992; Kokwaro, 1993, Omino & Kokwaro, 1993; Njoroge & Newton, 1994; Sindiga et al., 1995; Msafiri, 1996; Barret, 1996; Masinde, 1996; Kisangau, 1999; Maundu *et al*., 1999; Waiganjo, 1999; Kibet, 2002; Njoroge, 2002; Njoroge & Newton, 2002; Njoroge & Bussmann, 2006a,b,c; 2007; 2009). While the list of uses is long, only a few development projects have been

undertaken to validate and commercialise products from these plants.

The International Centre for Insect Physiology and Ecology (ICIPE) has had projects to improve the economic value of some of these plants. Two plants have been commercialised in collaboration with local communities. *Ocimum kilimandscharicum* was traditionally used as a home remedy for treatment of colds and flu, diarrhoea, abdominal pains and measles. Essential oils from this plant are now hydrodistilled and used to produce a commercial product referred to as 'naturub' found in many shopping outlets in Kenya. Over 200 farmers have domesticated this plant and hence provide the raw materials required for this project with enhanced incomes (http://www.icipe.org). On average, a farmer is estimated to make KShs.35,000-40,000 [US$ 437-500] when they cultivate the plant on a small plot (Institute of Economic Affairs, 2009). This other plant which ICIPE has added value to is *Mondia whytei,* by production of a commercial product 'Mondia tonic', which is sold as antidepressant, antioxidant, revitaliser, appetiser and for clearing hangovers. More research in medicinal utilisation of Kenyan indigenous plants and their potential for commercialisation and domestication need to be emphasised.

The Bioresources Development and Conservation Programme has also worked in collaboration with Shaman Pharmaceuticals with various cultural groups as collaborators in Nigeria to integrate traditional knowledge in drug discovery and development with the understanding that Shaman will distribute benefits after products commercialisation (Carlson, 1997). Shaman has developed a pioneering technology platform, integrating ethnobiology and modern science leading to discovery of multiple orally active antihyperglycemic leads in the diabetes drug discovery programme that are currently undergoing preclinical evaluation. Other products include Provir™, an oral product for the treatment of secretory diarrhoea, Virend®, a topical antiviral for the treatment of herpes and Nikkomycin Z, an oral antifungal for the treatment of endemic mycoses (http://www.netsci.org/Science/Special/feature11.html**).**

The part played by traditional communities in global healthcare also comes from medicines derived from the soils. Most of the bacteria accessions in the American Type Culture Collections (ATCC) come from developing countries mostly collected from the soils. Such communities where the soil sampling has been undertaken have contributed in the collection and knowledge of these resources (RAFI, 1994). A fungus collected from Brazil has been found to be lethal against fire ants. The Brazilians knew that there was something in those soils that kills fire ants. Other soil micro-organisms have been sources of anti-fungal agents and antibiotics. Such knowledge among traditional communities needs documentation and scientific investigations as well as drawing of benefit sharing contracts in the process of industrialisation. It known that the use of soils from various unique locations is part of the healing procedures among traditional healers world over. These soils on investigation have revealed presence of anti-tumour, antibiotic or steroidal characteristics (RAFI, 1994).

The use of natural resources as sources of medicines is not restricted to plants; there are many animals in Kenya and other African countries used as therapeutic agents. These include bats which are used for whooping cough, baboon (meat) used for managing malaria (prophylaxis), jackals' teeth used in wound healing, bones of warthog also find use in managing measles (Marshall, 1998). The urine of rock rabbit

(*Procavia capensis*) is an important medicinal product in South Africa, referred to as *hyraceum,* and used to treat various types of pains and as antidote for any type of poisoning (Van Wyk, 2008). Ethnozoology (study of the traditional uses of animals) is one of the disciplines in ethnobiology that is lagging behind but holds promising future for discovery of new health options in the pharmaceutical industry

3.0 TRADITIONAL KNOWLEDGE AND PEST CONTROL

Current studies have shown that excessive and inappropriate use of agrochemicals has resulted in negative effects on the environment and on human health. Natural products on the other hand, used for plant health enhancements have positive effects in stimulating soil microbial activity and thereby antagonistic potential in soils leading to a reduction in pests infestation and improved plant growth. Reliance on chemical pesticides to manage pest problems has aggravated environmental decline and caused serious health effects on agricultural workers and rural communities. Pesticide residues are also associated with bioaccumulation and consequently raised food safety concerns. Bio-agents therefore such as bio-pesticides have become the focus of research in an attempt to have strategies for improved and sustainable production.

An area of interest in this new direction is to screen plants known by traditional communities to possess insecticidal properties. Ethnobotanical studies have revealed about 1,600 plant species used as bio-pesticides in various communities (Lalonde, 1993). In West Africa, some of the recognised species include; *Chromolaena odorata*- leaves, *Azadirachta indica* leaves and seeds, *Capsicum annum*- dried fruits, *Citrus aurantiifolia*- ripe and unripe fruits, juice, *Piper umbellatum* - leaves and *Arachis hypogaea* - oil from seeds are among the popular specie (Cobbinah *et al*., 1999). In some cases, phytochemical and bioactivity studies have been undertaken revealing novel compounds with insecticidal properties (Wollenweber *et al.,* 1995) hence justifying their use in traditional stored grain preservation. *Azadirachta indica* yields the commercial azadirachtin which is an insect repellent and antifeedant that causes upset of insects hormone balance making the pest incapacitated (Ley, 1990). Other important insect pest antifeedants include ajugarin from *Ajuga remota* and Jodrelin from *Scutellaria* sp. Further surveys on the biological sources of traditional antipest extracts followed by scientific authentication may lead to breakthroughs in discovery of biopesticides hence improved food security. In each of these cases, when commercial products are developed, the value of the products is increased and therefore farmers providing raw materials or those involved in the marketing chain will derive more incomes, hence improved livelihoods.

A study in Mwingi, Kenya, has revealed several species used as stored grains protectants. These include: *Ocimum gratissimum* L., *Ocimum basilicum* L. (Lamiaceae), *Capsicum frutescens* L.; *C. annuum* L, (Solanaceae), *Maytenus senegalensis* (Lam.) Exell (Celastraceae) as well as two other commonly cited species in local language (*Nyaika*, *Neengia*) (Njoroge, *et al*., in press). Most of these plants have not been studied for their activity against known pests. This ethnobiological data need further documentation and validation so as to reduce losses associated with stored grain pests.

4.0 TRADITIONAL ECOLOGICAL KNOWLEDGE AND ENVIRONMENTAL MANAGEMENT

Development theory indicates that strengthening traditional natural resource management institutions leads to improved environmental and social welfare (Watson, 2003). The Maasai for example have been found to possess traditional rangeland classification systems that are useful in assessment of indicator species for livestock grazing suitability (Oba & Kotile, 2001). It therefore expected that when such traditional ecological knowledge is integrated in biodiversity management, it enhances natural resource monitoring. Many pastoralist communities in Kenya also possess traditional herd management practices that serve to prevent environmental strain by their animals during grazing. Such strategies include herd diversification so that the different traditional breeds take advantage of varying micro-ecological characteristics and vegetation types and keeping of resistant breeds (Akong'a & Kareithi, 1998).

Research has now shown that traditional communities have innovative ideas regarding soil erosion, soil fertility, intercropping, weed control, beneficial water and anti-desertification management practices. In Keiyo District for example, traditional topographical classifications coincide with those used in western-based ecology (Jungerius, 1997). Such knowledge has application in choosing development sites as well as management of agroecosystems particularly in choosing crop verities and land races for various ecological zones and soil types. Many beneficial traditional practices are yet to be documented and up-scaled in the process of industrialisation.

General unanimity exists that drought and famine are recurring events in sub-Saharan Africa. Recurring events become institutionalised and hence become part of culture (Hofstede, 1991). Rural communities therefore develop elements of disaster preparedness built within the production systems to minimise risks to food supply and livelihoods especially agrotechnical strategies (Akong'a & Kareithi, 1998). These strategies represent useful indigenous knowledge systems that need to be conserved and institutionalised for food security in industrial development.

5.0 TRADITIONAL KNOWLEDGE IN NON PHARMACEUTICAL NATURAL RESOURCE USE

Plants fulfill the three basic needs of man namely, food, shelter and clothing. Next to food clothing is next requisite of man. Current trends show that clothing industry is moving from synthetics towards natural fibres. There is much evidence to show that discovery of raw materials for textile industry came from traditional communities. Despite this fact, very few fibre plants used in traditional communities have been documented or commercialised.

In the textile industry for example, *Gossypium* sp. (cotton) was used among the Greeks and Romans and has become the greatest industrial crop of the world (Pandey and Chadha, 1993*). Linum* (flax) that was used a substantial area in the arid and semi-arid lands of Kenya, in other countries commercial cordage is obtained from these species. Potential for local species to produce industrial fibres need to be explored.

Gums and resins have been medicinal agents in traditional communities for many years. These natural products however have potential for manufacture of polish,gum which is used in other countries for calico printing. Although these species

are now seen as an ecological disaster, they have potential to contribute to the printing industry.

Spices were first used in Egypt, but with time they became an element of trade in early periods of exploration until today. They contain soluble pigment, carbohydrates, tannins, resins and volatile oils among other substances. The use of spices is deeply entrenched in traditional communities way of life. Among those in involved in trade are: ginger commercial flouring agent; tumeric used as dye, flavour and in perfumery industry; Rosemary a herb but also medicinal; cloves is the oldest spice especially in Zanzibar but now used in commercial production of mouth washes and toothpastes. While Kenya has a wealth of spice plants; many are not documented neither utilised as elements of trade.

Soap substitute plants are important in different communities as detergents.

With the industrial production of soap and other detergents these plants are rarely used. Their documentation and focus for further research is urgent and important. This is especially because some of the plants used in traditional communities as soap substitutes are now industrial plants for the production of: commercial saponins, foaming agents, cleaning agents especially for lenses and precision equipment.

6.0 COMMERCIALISATION OF NATURAL PRODUCTS AND SUSTAINABLE SUPPLIES

The trade of majority of traditional medicinal plants is based on resources from the wild and hence the demand is suspected to exceed supply (Gasengayire, 2003). Of the 1543 medicinal plant species traded in Germany for example, 93-98% are harvested from wild populations (Tiktin, 2004). Some of the animal species that are important sources of medicinal supplies in many African countries are also thought to be declining in natural populations or highly threatened. Some examples include ostriches (Sudan), the African wild ass and the green turtle (Eritrea), the black rhinoceros, the sea turtle and green turtle (Kenya), leopard, cheetah and tortoise (Zimbambwe), among others (Marshall, 1998).

As commercial interest in natural products increases, there is an obvious concern for conservation status of these biological resources. Decline of these resources especially may have serious repercussions on livelihoods of the people depending on them. Wild resources are also at risk arising from loss of indigenous knowledge as a result of acculturation and habitat loss arsing from increased human population among other factors (Lewis, 2003). One of the main constraints impeding the success of enterprises based on natural products is resource supply and sustainability (Ticktin, 2004). Sustainable harvesting strategies of these resources should be deliberately factored in the process of commercialisation to avoid resource degradation and unstable economic enterprises. An important consideration is to incorporate domestication process along the commercialisation process.

7.0 CONCLUSION

From the foregoing it is possible to conclude that traditional knowledge needs intensive documentation, and to be valued and utilised in the process of sustainable

development. While as some of the ethnological inventions and innovations appear simple they may be the basis for further breakthroughs in industrialisation especially in producing technologies that are in harmony with the environment. The high success rate realised in integrating ethnobotany in bioprospecting for new drugs from plants need to be extended to other biological resources. Ethnozoology is a potential source of significant data on traditional animal utilisation in various communities which can lead to discovery of novel natural products in the future. It is unfortunate that ethnobiology is not a taught subject in most institutions of higher learning. Taking into account the role played by ethnobiological data in natural products industry and considering that this is the fastest growing sector in agribusiness, there is need to integrate the subject in the curriculum and research for development agenda.

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