Health Impacts of Traditional Medicines and Bio-prospecting: A World Scenario Accentuating Bhutan's Perspective[*]

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Abstract

Life without natural products is unimaginable. It has provided mankind with oxygen, water, fire, food, clothing, shelter and medicine. Its public health impact is considerably high, especially of traditional medicines and nature-based modern drugs. The traditional medicines, despite its limitations, are addressing the health needs of millions of people worldwide. It is estimated that about 65-85% of the world population uses traditional medicines for their primary health cares. It is also estimated that about 39% of all 520 new approved drugs in 1983-1994 were natural products and out of that 74% were discovered as a result of bio-prospecting from plants used in traditional medicines. Traditional medicines are increasingly getting more popular mainly because: a) it is holistic system with less side effects; b) it is evolving as an evidence-based medicine; c) its ethno-medical knowledge is applicable to modern drug discovery programs. As there are many diseases that cannot be cured by the existing drugs and as there are increasing cases of drug resistance, there is urgent need for drugs that are effective against these pathogens. Probably, traditional medicines could provide a solution in fighting them both as a health care delivery mechanism and as a means of chemotherapeutic pool. Bhutan is fortunate to be gifted with rich natural bio-diversity and rich traditional medical knowledge. The positive health impacts of the Bhutanese

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traditional medicines are resoundingly felt by Bhutanese. Besides, there is huge potential for bio-prospecting in Bhutan. This paper highlights world scenario on the health impacts of the: 1) natural product-based traditional medicines, 2) the natural product-based drug discoveries, and 3) Bhutanese traditional medicine and potential of bio-prospecting in Bhutan.

Introduction

With the advancement in science and technology, remarkable progress has been made in the field of medicine including diagnosis, treatments and pharmaceutics. Recent drug discovery techniques based on structure activity relationships, computer modeling, combinatorial chemistry, high throughput screening and spectroscopy (MS, NMR, and IR) have triggered and spearheaded the discoveries of many natural and synthetic drugs. In 1999, world sales of pharmaceuticals (excluding veterinary medicines) were valued at ca. US$ 325 billion.

Despite these developments, of the known 30,000 human diseases or disorders, only one-third can some how be treated symptomatically with drugs and that too at a great economic and social cost. This is because of the fact that the drugs available today are still not very effective particularly with respect to the fight against drug resistant pathogens and newly emerging infections. This includes infectious diseases such as AIDS, influenza, tuberculosis and malaria as well as other chronic disorders like cancer, autoimmune disorders and central nervous system disabilities (e.g. Alzheimer's disease). They are incurable and often fatal causing great suffering and disability.

Hence, these diseases including resistant pathogens are of special concern to communities worldwide. There is an urgent need to find concrete solutions for combating such epidemics. Prevention of famine, drought, poverty, flood, war, political upheaval, economic failure, environmental depletion and pollution would be good solutions to reduce infections and the development of resistance. Strengthening and developing

traditional medicines through evidence-based research for use against the diseases especially the chronic ones and also against drug resistant pathogens is another potential area. Another most important strategy to combat both new as well as the re-emerging infectious diseases is to develop an arsenal of new drugs.

New drugs could be developed synthetically, but experience has taught us that the natural products are rich in structurally diverse bioactive molecules that quite often become potential candidates for new drugs. In fact, in 1996, six out of the top 20 pharmaceutical prescription drugs dispensed were natural products. Therefore, it is very important that mankind value and appreciate the role and impacts of natural products, traditional medicines and modern drugs discovered from natural products.

This paper presents the role and the impacts of the natural products, traditional medicines and the nature-based drug discoveries. It also describes the potential, constraints and future directions in the area of natural product-based traditional medicines and nature-based drug discovery programs accentuating Bhutan's perspectives.

Traditional medicines and their health impacts

Mankind has discovered medicinal plants as indispensable cures for many ailments. Although some cultures used individual natural products as medicines, many traditions propounded powerful combinations with different ingredients known as poultices, tinctures and mixtures. It is reported that the Mesopotamians were the first people to use the herbs like oils of cypress, cedar, liquorice and poppy juice for treating different ailments in 2600 B.C. Buddhist system of medicine known as gSo-ba Rig-pa that is currently practiced in Bhutan, Tibet and Mongolia is 2500 years old and its pharmacopoea records the use of as many as 2200 traditional prescription drugs.

In 1500 BC, Egyptian's developed the Ebers Papyrus that documented some of the 700 drugs including formulas such as gargles, snuffs, poultices, infusions, pills and ointments. The Chinese materia medica Wu-Shi Er-Bing Fang which contains 52 prescriptions date back to 1100 BC and the Indian Ayurvedic Medicine that dates to 1000 BC (Susruta and Charaka) documents the medicinal use of plants like *datura*, *aconitum, canabis* and *sarcostemma*.

From these ancient cultures, some of the knowledge reached Mediterranean countries through traders and migrations, and it was in Hippocrates's time in 460-377 BC that pharmacognosy reached its summit in Greece. In 300 to 322 BC, Theophrastus, who was a philosopher and naturalist, was the first to deal with the history of plants, which later on helped in the classification of plants, including herbs. In 78 AD, Pedanius Dioscorides, a Greek physician produced *De materia medica*, which described more than 500 medicinal plants and their uses in detail.

Galen (*ca* 129-199 AD) founded "Galenics" and taught pharmacy and medicine in Rome. Avicenna (980-1037 AD), a Persian pharmacist, physician, philosopher and a poet, described 1400 drugs and medicinal plants which greatly contributed to the formation of a codified Graeco-Roman Medicine in the 5th century. Paracelsus (1493-1541) administered dosage formulations separating "Arkanum" from non-active ingredients of drugs. Western medicine and pharmacy originated from this medical system.

In the USA, homeopathy that includes hydrotherapy, nutritional therapy, herbal therapy, manual manipulation and midwifery, which were founded by German physician Hahnemann (1755-18-43), became popular in 1830s. The National Centre for Complementary and Alternative Medicine (NCCAM) was established at the National Institute of Health, USA in the 1990s to independently develop and support research on Complementary and Alternative Medicine. The NCCAM categorised seven forms of therapies practiced

worldwide such as mind-body interventions, bio-electromagnetic therapies, alternative systems of medical practice, manual healing methods, pharmacological and biological treatments, herbal medicine and diet and nutrition.

The discovery of antibiotics and vaccines in the 20th century dramatically changed medical practice worldwide, and as a result a separate field of ethno-medicine emerged as an academic specialization focusing on traditional healing systems. Today, traditional medicines effectively addresses the health needs of millions of people including developed nations by completely different strategies and well defined approaches, and generally with minimal side effects. Current WHO estimates show that 75% of the French population, 30% of the Vietnamese population, and 40% of Indonesia's population uses traditional medicines; 77% of pain clinics provide acupuncture in Germany and 72% of registered western style doctors uses kampo medicine in Japan. In Bhutan, traditional medicine is an integral part of the health care delivery system. Almost 100% of Hospitals and some Basic Health Units provide traditional medical services.

Overall, traditional medicines provide primary health care needs to almost 65-85% of the world's population, including developed nations. In terms of economic value, traditional therapies contribute to US $ 60 billion a year, and the USA alone spends US $ 2.7 billion per year followed by China with US $ 1.8 billion and Australia with Aus $ 1 billion a year. In fact, the traditional medicine is gaining popularity worldwide and this is attributable to four of their main salient features: the use of natural products as ingredients, the concept of holism with minimal side effects as opposed to allopathic drugs, the emerging clinical efficacy and the content of reservoir of ethno-medical information.

As required by the WHO regulations, many traditional medicines are strictly monitored for their quality, safety and efficacy. Many traditional medical systems including Japanese Traditional Sino-medicine and Tibetan medicine

(gso-ba-rig-pa) have emerged as evidence-based medicines. For example, the investigation on the principal of drug action of the Japanese Traditional Sino-medicine resulted in obtaining many novel compounds and unknown new mechanisms of drug action. The clinical trials of Tibetan medicine, the PADMA Products also proved successful on treatment of Irritable Bowel Syndrome and fibrinolysis with stable intermittent claudication. It furnished new anti-oxidative mechanisms at the molecular level.

Thus, all these indicates that traditional medicines caters to millions of peoples worldwide in their primary health care needs.

Bio-prospecting and their health impacts

Other than providing primary health care, the natural products also play significant role in the discovery of the natural product-based drugs. The natural products like plants, animals, microorganisms, marine organisms and the extremophiles have been an important sources of the potential drug leads and this will continue for years to come. Many bioactive molecules have been isolated from these sources applying three main types of search strategies: bio-rational, chemo-rational and random approaches. For example, Conocurvone-an anti-HIV agent was discovered as a result of random approach of screening. Drugs such as artemisinin, morphine, quinine, and ephedrine were discovered using bio-rational approach. Out of these three search strategies, bio-rational approach is the most effective one. Bio-rational approach is mostly guided by the ethno-medical information generated from the traditional medicines. More than 13,000 species of plants are being used in the traditional medicines and herbal cosmetics and about 8000 of these medicinal plants species are known in South Asia alone. These natural products (medicinal plants) contain reservoir of etho-medical and ethno-botanical information, which is an important guide to discovery of many new drug lead molecules.

Recently at the National Cancer Institute (NCI, USA), although random high throughput screening method furnished a large number of testing extracts, it was found by *in vitro* bioassays that medicinal plants from traditional medicines gave greater rates of bioactivity. At the University of Illinois, Chicago, out of 800 medicinal plant extracts collected from Vietnam and Laos, at least 25 biologically active compounds were isolated; of these 13 were new anti-HIV agents and 3 were anti-malarial agents. In the USA, out of 119 plant drugs available from 1959 to 1980, 74% of these were discovered as a result of chemical studies directed at isolating the active substances from the plants used in traditional medicines. In fact, Cragg et al. estimated that 39% of all 520 new approved drugs in 1983-1994 were natural products, and 60-80% of antibacterial and anti-cancer drugs were derived from natural products. Analysing the USA based community prescriptions in 1973, it was found out that 25.2% of the prescription drugs were plant derivatives, 13.3% were microbial derivatives and 2.7% were animal derivatives.

The search for new drugs continues, but mostly using the ethno-directed bio-rational approach. In 1999, the NAPRALERT database recorded more than 88,000 natural product isolates and many of them formed the skeletal framework of many renowned drugs available in the market today. For example, mevastatin (compactin) and lovastatin which were isolated from *Penicillin* spp became the cholesterol lowering drugs. Ivermectins isolated from the *streptomycetes* spp became an anthelmintic and antiparasitic drug. Reserpine was isolated from the plant *rauwolfia serpentine* and was turned into antihypertensive drug. Ephedrine isolated in 1923 from *ephedra sinca* formed the basis for the synthesis of salbutamol and salmetrol which are the anti-asthma drugs (beta agonist). Atropine comes from belladonna and even aspirin was derived from salicin present in willow bark. Teprotide was isolated from the venom of the pit viper, *bothrops jaracaca* and this formed the skeletal framework of the captropril and enalopril, which are used in treating cardiovascular diseases.

In the class of anti-cancer drugs, the vincristine and vinblastine isolated from *catharanthus roseus* are clinically used as the anti-cancer drugs today. Another anti-cancer agent, paclitaxel (taxol) was discovered from pacific yew, *taxus brevifolia*. Semi-synthetic drugs topotecan and irrinotecan were derived from camptothecian that was isolated from Chinese ornamental tree, *camtotheca acuminate*. *A*n anti-tumor agent, podophylotoxin isolated from the roots *podophylum peltatum* is effective in treating skin cancer and the warts. Its semi-synthetic derivatives, etoposide and teniposide, is used against the lung and testicular cancers, lymphomas and leukemia and against the acute lymphatic leukemia, neuroblastoma in children, non-hodgkin's lymphomas and tumors in adults respectively. In the mid 1980s, bryostatin-1 was isolated from *bugula neritina,* a marine bryozoans, and was found effective against ovarian carcinoma and non-Hodgkin's' lymphoma. Aplidine, isolated from *tridid*e*mum solidum,* a marine tunicate is in phase II clinical trials in Europe. Ecteinascidin 743, a metabolite from *ectelinascidia turbinate* tested for *in vivo* activity against the murine B16 malanoma and human MX-1 breast carcinoma models, is currently in Phase II clinical trials in Europe and US. Squalamine isolated from *squalus acanthias* is in phase-I clinical trial.

In the line of antimicrobial and anti-plasmodial drugs, microorganisms have been the popular source of antibiotics, ever since the discovery of penicillin from the filamentous fungus *penicillium notatum* by Alexander Fleming in 1928. Cyclosporins and rapamycin (an immunosuppressive agent), streptomycin, chloramphenicol, tetracyclines and cephalosporin (antibiotics) were isolated from the *streptomyces* and *penicillium* species. Provir, an oral product for the treatment of respiratory viral infections, and virend, a topical antiviral product for the treatment of herpes (both in clinical trials), were very recently developed from plant alkaloids. The sulphonamides were the first group of effective anti-bacterials to be developed following a chance discovery of

antibacterial activity in synthetic Azo-dye-prontosil in 1932 by Dogmak, and since then many antibacterial drugs were developed in between the late 1940s to 1980s. By then most of the infectious diseases were almost eradicated in the developed world, and as a result, almost half the major pharmaceutical companies in Japan and the USA stopped their antibacterial drug development programs. Even today, antibacterial agents make up only 12-15% of the total pharmaceutical business, and thus, there are very few drugs that are effective against the infectious bacterial pathogens especially the resistant bacteria.

As there are many diseases that cannot be treated by the existing drugs and also as the drug resistance by many pathogens are increasing, it is evident that there is need for the development of new arsenal of drugs to combat them be it synthetically or based on the natural products. The World Health Organization has estimated that about 50,000 people die worldwide every year from infectious diseases alone. The lead cause of death is HIV-AIDS, followed by tuberculosis and malaria. In 1996, the approximate figure showed that the HIV virus had infected at least 21,000,000 people worldwide and in 2001, UNAIDS estimated that over 14,000 new infections occur daily, nearly half of them in women and strikingly affecting Africa. While malaria continues to claim 1-3 million lives each year, ca. 2 billion people including at least 15 million Americans are affected by tuberculosis.

These infectious diseases (microbial) will continue to be the leading cause of premature death in human beings of both developed and developing nations as their resistance to many conventional drugs is increasing. For example, *plasmodium falciparum* have already developed resistance to the existing traditional anti-malarial drugs like quinine, chloroquene mefloquene and even to the second line drug pyrimethamine-sulphadoxine (fansidar) and halofantrine. The resistance to the combined drug therapy has been reported in Africa, Thailand, Burma, Laos, Vietnam, Cambodia and China and there is hardly any anti-malarial drugs in line to fight the

resistance. The latest anti-malarial drugs artimisinin and its derivatives, artemether and artether, isolated from *artemesia annua* is the only effective anti-malarial drugs available in the market. This is the only hope of saving millions of lives especially in Sub-Saharan Africa where children are affected worst.

Similarly, many anti-bacterial, anti-fungal and antiviral drugs are becoming obsolete as the microbes have evolved numerous defenses against antimicrobial agents and drug-resistant pathogens are on the rise. The first resistance case was reported as soon as the introduction of chemotherapy in s*taphylococcus aureus* in 1941. *Mycobacterium tuberculosis* that causes tuberculosis emerged resistant to streptomycin in 1940s and by 1950s and 1960s, it also developed resistance to later drugs isoniazid and rifamycins. Streptococci that causes nosocomial infections showed innate resistance to drugs, including cephalosporins, clindamycin and aminoglycoside. The S*taphylococcus aureus* have currently developed into multi-drug resistant strain and threaten to put an end to successful chemotherapy. Vancomycin resistance among enterococci became noticeable in 1987 and has resulted into a true 'super bug'. The summary of bacterial resistance to chemotherapy is shown in table 1.

Table 1. Bacteria that have acquired resistance to some drug therapy.

Resistant type	**Bacteria**	**Disorders**	**Date (approx.)**
Penicillin resistant	*Pneumococci*	Pneumonia & meningitis	Mid 1970s-present
	Legionella	Legionnaire's disease	Mid 1970s-present
	Borrelia burgdorferi	Lyme disease	1980s-present
	Salmonella	Gastrointestinal disorders	1980s-present
	Staphylococci	Toxic shock syndrome	1980s
	E.coli O157:H7	Gastrointestinal	Mid 1980s-

		disorders	present
Multi-drug resistant	*M.tuberculosis*	Tuberculosis	Late 1980s-present
Vancomycin resistant	*Enterococci V.cholerae*	Wound, blood, enteric infections Cholera	Late 1980s-present
Multi-drug resistant	"super bugs"		2002-present

Source: Dax, S.L. Antibacterial Chemotherapeutic Agents. First ed. London, UK: Blakie Academic & Professional, Chapman & Hall. 1997.

Thus, there is immediate need to find new anti-microbial drugs active against the resistant and re-emerging diseases. It would be only wiser and better to turn to nature for finding new and effective drugs. It is estimated that ca. 250,000 to 500,000 species of plants grow on earth but only 10-15% of such species are reported to have been studied phytochemically for medicinal applications. There are 30 million species of insects and very few have been studied for bioactive molecules. Marine world represent 70% of earth's surface but only 5% of the marine organisms are explored. Only an estimated 1% of bacterial and 5% of fungal species have been examined to date. Extremophiles such as alkalophiles, halophiles, barophiles, thermophiles and psychrophiles have been neglected so far. These extremophiles would definitely offer a potentially diverse source of novel bioactive molecules.

All the above reviewed figures suggest only one thing: that is, the natural sources are least explored for medicinal applications despite the huge availability of the natural resources and immense potential for discovery of new drugs. When there is need for the new drugs, it is only befitting to systematically explore the rich natural resources and may be even the drugs for HIV-AIDS can be discovered. This would save millions of lives worldwide and definitely this means positive impacts to the health of the people worldwide.

Bhutanese traditional medicine: Its health impact and the potential of bio-prospecting.

Bhutan is rich in traditional-cultural diversity and natural resources. Probably, the rich natural resources hosted by the un-scalable topography of the country facilitated the growth of luxurious traditions and cultures. Such phenomenal gifts are rare to find in many countries. One of the tangible traditional assets of Bhutan is the traditional medical practices. Bhutan host two forms of traditional medicines: local healing practices and the formalized traditional medical system which is locally known as *gSo-ba-rig-pa* (Bhutanese Traditional Medicine). While local healing practices are an oral medical traditions that lacks proper documentation, *gSo-ba-rig-pa* medical system is highly sophisticated and fully documented. It is based on Buddhist philosophy and adopted principles of Chinese Traditional Medicine, Indian Ayurvedic Medicine and Persian Medicine.

Some sources noted that gSo-ba-rig-pa in Bhutan took shape with the advent of Mahayana Buddhism from Tibet in the 8th century, but there are other sources stating that gSo-ba-rig-pa developed subsequently in Tibet and Bhutan during the coming in of great Buddhist saint called Guru Padma Sambhava from India in the eight century. However, for sure it is clear that gSo-ba-rig-pa in Bhutan originated in the 8th century under the tutelage of Guru Rimpoche. This is substantiated by the fact that Khandro Yeshi Tshogyal, a consort and a disciple of Guru Rimpoche meditated on rdu-rtsi sman-gi-bchued-lan brgya-tsa brgyad at Mon-kha Nye-ring, Singye Dzong. In 1616, during the reign of Shabdrung Ngawang Namgyal, Minister of Religion, Tenzing Drukgyal, who was an esteemed physician started the propagation of gSo-ba-rig-pa in Bhutan. After the year 1885, the Penlops and Dzongpons and Desis patronized the profession by privately employing an esteemed physicians trained in gSo-ba-rig-pa. Drungtsho Pemba was the personal physician to the first King. Drungtsho Penjor and Mahaguru served at the court of the second King. In 1967, the third King, Jigme Dorji Wangchuck ordered the establishment of a separate

traditional medicine dispensary at Dechencholing, Thimphu. In 1971, formal training for Drungtshos (traditional doctors) and sMenpas (traditional compounders) was initiated in Bhutan, providing a solid professional base for gSo-ba-rig-pa. Today, gSo-ba-rig-pa has been integrated with the modern health care system and ultimately broadened the health care choices to the patients. Only few countries support the practices of traditional medical system along side biomedicine and even fewer countries (e.g. Bhutan, China, Mongolia and Vietnam) officially recognize and support one integrated medical system under same Ministry and Health Care Delivery System. This experience of integrating two conceptually very different health care systems within one ministry contain important managerial lessons to be learnt by others.

Currently about 29 traditional medicine units attached to modern district hospitals and the Basic Health Units (BHUs) functions efficiently under the guardianship of the Institute of Traditional Medicine Services (ITMS). The ITMS manufactures about 98 different essential traditional medicines using 300 different medicinal ingredients. The National Traditional Medicine Hospital in Thimphu alone treats more than 30,000 patients annually and the district Traditional Medicine Units treats about 20-30% of the total daily OPD patients of the district hospital. gSo-ba-rig-pa is getting more popular amongst the Bhutanese populace. It is also attracting international interests after it is being recognized by the World Health Organization as one of the important traditional medical system responsible for delivering primary health cares. Such popularities would mean pressure on the supply of traditional medicines thereby emasculating its sustainability. To achieve sustainability in raw materials and traditional medicines, ITMS and the Medicinal and Aromatic Plant Section (MAPS) under Ministry of Agriculture have jointly initiated the inventory development, domestication and cultivation trials of the rare and endangered medicinal plants species.

Beside providing health cares, gSo-ba-rig-pa also forms a unique opportunity for bio-prospecting in Bhutan since it is rich in ethno-medical information. The Bhutanese flora and fauna are characterized by an outstanding bio-diversity and a large number of endemic species, many of which forms part of the gSo-ba-rig-pa pharmacopoeia. Therefore, Bhutan's rich bio-diversity may be hosting cures for many diseases including AIDS, cancer and other infectious diseases.

Recently, a research carried out at the University of Wollongong on two Bhutanese medicinal plants *aconitum orochryseum* and *corydalis gerdae* revealed three new and four known novel compounds with significant antimalarial activities against resistant strains of *plasmodium falciparum*. Further study on this finding would also result in obtaining unknown new mechanisms of drug action.

Many medicinal plants such as *aquilaria agallocha*, *rauwolfia serpentina*, *paris polyphylla*, *sapindus mukorossi, phyllanthus emblica, terminalia bellirica, terminalia chebula, ephedra gerardina*, *taxus bacccata*, *rheum nobile*, *rheum accuminata*, *picrorhiza kurroa*, *podophyllum hexandrum*, *nardostachys jatamansi*, *aconitum* species, *artemisia* species, *panax pseudo-ginseng* sub-species *himalaicus* and *cordyceps sinensis* are in high demand for pharmaceuticals and cosmetics. Commercializing and bio-prospecting these medicinal plants would not only accelerate the Bhutan's economic growth, but also contribute to the global stock of pharmaceuticals. Thus, gSo-ba-rig-pa (Bhutanese traditional medicine) has lots of potentials in terms of the provision of the primary health care as well as in the discovery of new drugs if strategically managed and developed considering the innate intellectual property rights.

Conclusion and future directions

Natural products have been the basis for the formation of traditional medicines and for the discoveries of many modern drugs. Without the natural products, life will cease to function, and almost every cultures and traditions including

the traditional medicines and drug discoveries can be handicapped. This is because the flora and fauna of our planet provide at least 50% of all pharmaceuticals and almost 85% of the world's population depend on traditional medicines for their primary health care needs, which will continue forever.

In many countries, traditional medicines are deeply rooted in their cultures. It has become an indispensable treatment regimens and a subject of interests for the pharmaceutical companies for the following reasons: a) it is holistic in nature and has no side effects as opposed to modern allopathic drugs; b) the traditional medicines are cheap and easily available in the markets (raw materials), especially in developing countries as compared to modern drugs which are very expensive; c) most of the traditional medical systems are supported by long clinical use with properly recorded pharmacopoeias and are being supported by the scientific validation processes; and d) traditional medicines are the reservoirs of ethno-medical and ethno-botanical information which are the keys for opening many new modern drug leads.

As the diseases are increasingly developing resistance to the existing drugs and as there are newly emerging disorders, it is only natural that the natural products, traditional medicines and drug discovery programs will even become more indispensable. In an effort to fight the diseases, disorders and sufferings; there is urgent need for new and effective arsenal of drugs (applies to allopathic as well as traditional medicines). The world still has 80-85% of the natural products unexplored for medicinal applications. The effective medicines can be discovered only through trans-disciplinary co-operations and collaborations among the scientists, medical doctors and traditional physicians. It will not help anybody by professional turf building, working on the professional economic gain and the politicizations of the medical practices and pharmaceutical works. Health care is more likely to be integrative, holistic, safe and effective when medical practitioners (conventional and traditional medicines)

and scientists consider the welfare of the client or patients above their own interests.

There is also immediate need for country to country co-operations and collaborations. Some developing countries are extremely rich in biodiversity and traditional medical knowledge but lacks the technologies and financial resources to meaningfully explore and add value to them. On the contrary, the developed countries are rich in technologies and financial resources but lacks in the natural resources and the traditional medical knowledge. It would be better to come together, bridge these gaps and differences and come up with effective cures for the un-forgiving diseases.

Bhutan is fortunate to be gifted with rich biodiversity and traditional medical knowledge that could pioneer successful bio-prospecting. However, like any other developing countries, Bhutan lacks technical expertise and financial resources to explore them meaningfully. The only option Bhutan have is to collaborate with the developed nations and interested pharmaceutical companies alike and jointly explore them strategically and wisely. In doing so, the model of collaboration should be such that it builds the science infrastructure within, preserve and protect the local traditional medical knowledge reducing the brain drain, and equally share the outcome of the joint projects. While bio-prospecting should gear up, strengthening the Bhutanese traditional medicine should be a simultaneous effort since it has multi-pronged benefits. First, it has significant contribution to the health of the Bhutanese; second it is manufactured in Bhutan using the country's luxurious medicinal plants and other raw materials benefiting many businesses and farmers; third, it provide employment opportunities; and fourth, it uses more than 300 medicinal materials that could be useful for bio-prospecting. In fact, it is the nerve centre with many development networks that promotes ethical and sustainable utilization of bio-resources to benefit farmers, business people, human health and the environment in Bhutan. This traditional medical system

embraces all the four pillars of Gross National Happiness. Also, it will be a yardstick for the discovery of new drug leads that could save millions of lives. It is therefore important that there is continuing support for protecting, promoting, and propagating this traditional medicine and also in preserving our rich biodiversity. Perhaps, our biodiversity may be hosting cures for HIV-AIDS, Cancer, Hipatitis B and many other chronic diseases.

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