CHAPTER 1

THE CHALLENGE OF NON-EXPERIMENTAL VALIDATION OF MAC PLANTS

Towards a multivariate model of transcultural utilization of medicinal, aromatic and cosmetic plants

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Abstract. Following a short review of the role traditional knowledge, beliefs and practices concerning medicinal plants and herbs from the newly discovered worlds have played in the past, in the formative period of botany and pharmacology in the West, the implications are indicated of the emergence of Cartesian rationalism in science, in particular in the medical social sciences. Then, the recent reassessment of the human dimension in human–plant relations is described in terms of the 'rediscovery' of herbal medicine, the integration of traditional medicine in primary health care, and the growing interest in many Western countries in complementary and alternative medicine (CAM).

Despite the rather solid position of biomedicine, based on advanced drugs, infrastructures and technologies, the emerging limitations in finding adequate responses to some 'new' diseases, chronic complaints and mental disorders – characteristic for the more affluent countries – are shown to have recently not only strengthened the popular reorientation towards natural products and traditional herbal medicines, but also given an impetus to the recognition and validation of phytopharmaceutical products for health promotion and the treatment of some specific diseases.

Thereafter, the long and difficult road to the scientific, experimental validation of traditional medicinal, aromatic and cosmetic (MAC) plants is indicated, highlighting the major obstacles of increased risk, extremely high costs, and prolonged times involved in the entire process. Whereas a number of utilitarian studies have been involved in experimental ethnobotanical research of these MAC plants for 'new' drug development, yet little emphasis has been given to the human dimension of the underlying people–plant relations and interactions. However, the progress made in the development of the promising 'ethno-directed approach' to drug development is presented against the background of the interdisciplinary input from medical-ethnobotanical and ethnomedical research, in which a growing

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recognition is presently evolving of the role of 'soft' socio-cultural factors in the overall healing process, such as indigenous knowledge, perceptions and beliefs, too long ignored in the quest for providing adequate health care. While most of these studies on indigenous plant knowledge tend to examine the role of medicinal plants in one culture, only a few compare plant use among different traditional cultures in which special attention is placed on the efficacy of transcultural plant utilization among and between traditional and modern medical systems.

In this context, the need for further analysis and understanding of both 'hard' and 'soft' factors involved in the interactive process of MAC plant utilisation is underscored, pertaining to the contribution which recent advances in quantitative ethnobotany have provided to the development of a more human-oriented method of validation of MAC plants in developing countries.

Embarking on the newly developing field of *ethnobotanical knowledge systems* (EKS), a specific contribution to the methodology of non-experimental validation (NEV) is presented on the basis of a multivariate model of MAC plant utilization behaviour, capable to analyse, explain and predict the interaction among various categories of factors related to the local people's knowledge, belief and use of plant-based medicines. Indeed, by application of such multivariate model, a much wider range of factors are included in the analysis, yielding relevant information not only on the local priority plant species list, but also on outcome criteria on both the individual and the system levels. These include the people's considerations for using particular plant-based medicines in a special mode for specific disorders, their perception, experience and satisfaction, as such providing a promising complementary contribution to the multiple validation process of MAC plants for improved health care for peoples and communities around the globe.

Linking up with the basic, quantitative and experimental research phases of future medical ethnobotany, envisaged by Lewis and Elvin-Lewis (1994), this chapter not only attempts to combine the latter two research strategies in order to extend multiple research methods in validation, but also to further substantiate the cultural dimension of human–plant relations, so far largely neglected in medical ethnobotanical drug research and development.

Keywords: bio- and ethnomedical systems; complementary and alternative medicine (CAM), ethnobotanical knowledge systems (EKS); multivariate analysis; quantitative ethnobotany; traditional medicine.

INTRODUCTION

Traditional medicine in terms of a culture-bound body of indigenous medical knowledge, belief and practices has provided the primarily plant-based foundation for many ethnomedical systems which already existed long before the development of 'scientific' or cosmopolitan medicine. While ethnomedicine has been practised since prehistory by virtually all human cultures around the globe, including not only the 'Great Traditions' of Hippocratic-Galenic medicine of ancient Greece (Figure 1; see colour pages elsewhere in this book), the Unani Tibb of Arabia, the Ayurvedic of India and Chinese medicine in Asia, but also the 'Little Traditions' in Africa, Europe, Asia and the Americas, it was not until the 16th century that the European expansion brought a wealth of 'exotic' plants, herbs and spices, and related indigenous knowledge and wisdom from the tropics to Western Europe. In this way, traditional plant-based medicine from overseas in combination with the revalidation of classical Greek medicine of the Renaissance constituted to a great extent the formative period of time of modern scientific botany and pharmacology.

At the beginning of the 19th century, however, the introduction of Cartesian scientific materialism into all human activities, including health and healing, pertained to a new philosophy of life which subjected all assumptions to experiment and statistical validation, forecasting a future of empirical research and technical innovation. By consequence, belief, emotion and intuition as immeasurable

conditions by scientific parameters were belittled and replaced by doubt or distrust. Moreover, the modern medical methodology sought to break up complicated phenomena and processes into smaller components which had to be dealt with separately and in isolation, often by distinct sub-disciplines, as such largely ignoring the principles of synergy and holism. While in diagnosis, the focus was generally laid on the search for *one* single cause, to be cured ideally by *one* remedy, in pharmacology the quest was likewise for *one* active component to be identified and isolated. Undoubtedly, the development and implementation of the scientific methods and techniques in medicine have brought enormous improvements, specifically in all those conditions in which material phenomena, including infection, injury, poisoning, nutrition and hygiene, are major factors in the disease etiology. Especially in public health, modern medicine has substantially contributed to the decrease and eradication of some major epidemic diseases such as typhoid and cholera, bacterial infections, parasitic diseases, smallpox and polio.

Although the contribution from the discovery of anti-bacterial agents after World War II to the successful fight against infectious and parasitic diseases has been dramatic, recently some problems of bacterial resistance and parasitic immunity to synthetic bio-chemical drugs are creating reason for increased international concern.

In degenerative conditions and in disorders, however, where mental, chronic, allergic, behavioural, emotional and spiritual factors are playing a determining role, the results are disappointing, and deterioration is becoming rather evident everywhere. In the realization that just these psychosomatic and mental disorders, chronic ailments and allergies are increasingly constituting the most common afflictions of humankind where modern medicine can hardly provide an adequate therapy, the philosophy, function and approach of the scientific cosmopolitan health-care system is more and more being questioned, both in- and outside the medical circles.

Following the emergence of relatively new, so-far incurable 'cultural diseases' such as obesity, diabetes, hypertension and HIV/AIDS, the unequal coverage of modern medicine – practically confined to the richest countries in the world and to the urban elites in the developing countries – and the almost unacceptably staggering high costs of technologically advanced modern medicine, there exists little doubt that today's search for alternative solutions and approaches is rather timely and appropriate.

In this context, it is not surprising that the worldwide movement of 'back-to-nature' among clients, patients and the general public has grown out of the recent emergence of a 'chemophobia' against industrially produced, sometimes less effective medicines and unwanted side-effects. While in many developing countries, the age-long, persistent reliance on traditional herbal medicine recently has undergone a revival – encouraged by integrative strategies from international organizations such as WHO, UNICEF and UNIDO – the public interest in Western countries in knowledge and use of non-Western traditional herbal medicines, represented by numerous books, journals, documentaries and exhibitions, has increased tremendously, forcing many governments to open up their health-care systems to these alternative forms of complementary and alternative medicine

Similarly, parallel developments in the social sciences, notable in the interdisciplinary field of medical anthropology, ethnomedicine and medical ethnobotany, have led to the development of new approaches to identify, document and analyse indigenous medical knowledge and practice – particularly in the field of medicinal, aromatic and cosmetic (MAC) plants – which could indeed prove to encompass innovative wisdom for future sustainable development of the medical social sciences.

As compared with conventional random sampling for natural compounds, a more successful method in bio-prospecting has been developed on the basis of traditional knowledge and practice regarding medicinal plants of traditional healers, birth attendants and their patients, known as the *ethno-directed sampling* of indigenous plant collections. In his comparison of efficiency of random versus ethno-directed research, Balick (1990; 1994) shows that ethno-directed sampling provides a comparatively greater proportion of useful plants containing bioactive chemicals: in this approach, the percentage of identifying a pharmaceutical lead may increase from 6 % to about 25 %. In addition, Cox (1994) has predicted that properly designed ethnobotanical surveys could prove particularly successful in identifying drugs to treat gastrointestinal, inflammatory and dermatological complaints.

However, despite the advancement in multiple research methods and techniques in the search for new drugs, conventional validation of bioactive components in plants species has tended to dominate the endeavours, and continues to remain very costly, risky and time consuming.

Among the factors that lead to such high costs is the local practice of use of multiple plant mixtures in traditional medicine, posing complex problems to plant-screening techniques. Instead of isolating the single plant species in validation, the complete plant mixtures should also be included in the analysis of the intricate chemical interactions that take place among bioactive components of these plant mixtures. Similarly, preparations of mixtures of plants have shown either to increase the activity of compounds or to diminish the toxicity. While Etkin (1993) had argued that such multiple plant mixtures need to be included in the scientific validation process because of the complex chemical interactions among constituents of one single plant and with mixtures of different plants, Heinrich et al. (1992) argued that plant screening against microorganisms not necessarily provides proper evaluation of the plant's actual use.

By consequence, the use of traditional botanical knowledge as a promising instrument in bio-prospecting for useful plants for both human and animal medicine has recently increased, rendering ethnomedical and medical ethnobotanical research methods and techniques rather contributive to validation and development of new plant-based drugs (Slikkerveer 2001; Quah and Slikkerveer 2003; Lans 2001). Still, this type of research basically remains oriented to the proper plant species and their assumed bioactive components.

Linking up with the development of complementary research methods of non-experimental validation by Browner et al. (1988), Heinrich et al. (1992) and Lans (2001), this chapter seeks to provide a contribution from recent advances in quantitative ethnobotany by further developing a multivariate model of transcultural utilization of MAC plants for health improvement that allows for the study, analysis

and integration of a wider range of significant determinants of traditional herbal knowledge, belief and practice into the multiple research process. In line with the basic, quantitative and experimental research phases of future medical ethnobotany, envisaged by Lewis and Elvin-Lewis (1994), it not only attempts to combine the latter two research strategies, but also to further substantiate the cultural dimension of human-plant relations, so far largely neglected in medical ethnobotanical drug research and development.

MAC PLANTS: EXTENSION OF THE MAP CONCEPT

While economic botany as one of the major sub-fields of ethnobotany has largely focused on the economic value of useful plants since the early botanical discoveries of tobacco, maize, rubber and cocoa in the New World, preceded by encounters with Eastern spices such as cinnamon and black pepper, the related fields of ethnobotany and ethnomedicine were mainly involved in the study of 'exotic' medicinal, aromatic and cosmetic plants and herbs. The early use of ingredients from plants in secret recipes for cosmetic use is well known from ancient Egypt, where the pharaohs guarded their secret formulae as early as about 3,000 years ago. From North Africa, the art of the preparation of largely plant-based cosmetics – generally associated with famous names of rich ladies such as Nefertiti and Cleopatra – spread from Africa into Babylon, Assyria and Greece, soon to become part of the lifestyle of the aristocracy throughout the Mediterranean region and the Middle East (Figure 2; see colour pages elsewhere in this book).

As the interest in medicinal and poisonous plants – combined into one commodity group as both are mainly used as medicine – expanded tremendously, lately also providing a significant basis for the development of new drugs, soon the study of aromatic plants as an overlapping category evolved, generally paying due attention to those plant species that provided fragrance and essential oils. In addition, 'spices' also include numerous aromatic plants (Swahn 1995). The European Union, in its *Glossary of Biodiversity-Related Terms* (2005) applies a similar overlap by defining medicinal and aromatic plants (MAPs) as plants primarily used for medical or aromatic purposes in pharmacy and perfumery. Previously, WHO (1998) had excluded from its definition of herbal medicines those drugs that are based on already isolated or synthesized plant materials, as formulated in its *Guidelines for the Appropriate Use of Herbal Medicines*.

Analogously to the distinction in herbal medicines between raw plant materials, processed plant materials and medicinal herbal products, De Padua et al. (1999) distinguish three different types of herbal medicine: *traditional medicine* referring to the use or consumption of an indigenous medicinal plant in its country of origin; *herbal medicine* denoting the cultivation and processing of the same medicinal plant in the country of origin into a formulation of herbal medicine to be sold in Western countries; and *pharmaceutical medicine* if the same plant may provide a lead compound for a pharmaceutical product. Balick et al. (1996) argue that these systems of medicine are complementary in health care and cannot substitute one another.

The wish for implementation of accurate definitions in the study and analysis of wild and cultivated plant species is also embodied in the *Global Plan of Action* of FAO (1996), adopted by 150 countries and the European Community, promoting the conservation and use of wild plants for food and agricultural production. By consequence, the objectives of the *Network on Identification, Conservation and Use of Wild Plants in the Mediterranean Region* (MEDUSA) include the identification of native and naturalized plants of the Mediterranean Region, used as: 1. food (including food and beverages, for humans); 2. food additives (incl. processing agents and additive ingredients used in food preparations); 3. animal food (incl. forage and fodder for vertebrates); 4. bee plants (incl. pollen or nectar sources); 5. invertebrate foods (incl. plants eaten by invertebrates useful to humans, e.g., silkworms); 6. materials (incl. woods, fibres, tannins, latex, resins, essential oils, waxes, oils); 7. fuels (incl. fuel wood, charcoal, fuel alcohol); 8. social uses (incl. masticatories, smoking, psychoactive drugs, contraceptives, abortificients, plants used for ritual or religious purposes); 9. vertebrate poisons (incl. both accidental or useful poisonous plants, e.g., for hunting, fishing); 10. non-vertebrate poisons (incl. accidental and useful poisons e.g. molluscicides, pesticides); 11. medicines (incl. human and veterinary uses); 12. environmental uses (incl. ornamentals, barrier hedges, wind brakes, soil improvers, erosion control); 13. gene sources (incl. wild relatives of major crops); and 14. cosmetic plants (for human health and human body decoration) (Heywood and Skoula 1998).

Soon, however, the overwhelming volume of plants used for cosmetic purposes in the region prompted the Network to extend its list with the distinct category of plants with cosmetic uses (Yazan and Can Baser 1997; Slikkerveer 1997). Similar experience with the complicated identification of medicinal plants – *jamu* – in Indonesia, where cosmetic use of plants for health and beauty have been a major part of the cultural heritage of the archipelago over many centuries, has further underscored the practical need of the distinction between medicinal, aromatic and cosmetic (MAC) plants (Quah and Slikkerveer 2003). Such refinement in the categorization of medicinal and aromatic plants is transpiring through a recent review of industrial uses of medicinal plants in developing countries (De Silva 1997).

From the ethnobotanical/ethnomedical point of view, the application of the extended categorization of MAC plants has also shown to link up with several indigenous classifications of useful plants in Java and Bali, and as such further substantiated the *emic*[1] view on indigenous plant knowledge, belief and use, crucial to the understanding of the position of medicinal plants in local health-care improvement and forest conservation around the globe (Agung 2005; Leurs 2005; Ibui 2006). As such, the arguments for extension of the concept of MAC plants are not only based on considerations of overlapping definitions, economic value and the promotion of health and beauty, but also on the socio-cultural perceptions and classifications of the indigenous and traditional peoples involved.

THE 'REDISCOVERY' OF HERBAL MEDICINE

Medicinal plants and herbs have always played a major role in the development of medicine and public health in both Western and non-Western countries, as reflected in the historical process of cultural contacts that goes back to the pre-Renaissance times of the great European explorations of the non-Western world. After the initial fascination for traditional medicinal plants as potential resources for the Western *materia medica*, the interest declined after the accumulating 'scientific' discoveries of germ theory, antibiotics and advanced medical technologies made since the late 19th century. However, a growing disappointment in biomedicine incapable to find adequate and affordable responses to various 'new' diseases', including cancer, HIV/AIDS, diabetes, hepatitis. allergies and mental disorders, have recently flared up the debate on the possible integration of traditional and modern medical systems and their medicines.

As De Silva (1997: 35) notes: "*The promotion and development of processing of plant-based products have been given a fresh impetus due to certain ground realities"*. In his view, these realities include green consumerism and the resurgence of interest in the use of 'naturals' in developed countries; the free market economy bringing in more openness and expanding markets and demand for new resources and products; growing acceptability of the social responsibility of minimizing socio-economic inequalities in favour of rural people; poor economic conditions in developing countries rendering an increased reliance on local plant-based medicines; increasing awareness regarding biodiversity conservation and sustainable and protective use of plant resources; and the search for new phytopharmaceuticals for the prevention and cure of deadly diseases such as Cancer and HIV/AIDS.

While prolonged control and legislation of alternative practitioners in conjunction with the 'scientific' validation and approbation of new medicines had hindered the expansion of truly integrated health-care services for a long time, expanding patient associations, increased health-care demands and affirmative action – supported by increased cultural contact – have come to press for social acceptance and official endorsement of alternative therapies, both in clinical practice and in health-insurance schemes (Weeks 2001).

However, the market did not only experience an increase in the demand by clients and patients for prescribed and over-the-counter plant-based medicines, but the pharmaceutical industry itself also witnessed a resurgence of interest in natural products following some disappointing results from rational drug design, research and biotechnology (Farnsworth et al. 1985; Principe 1991).

With the above-mentioned, worldwide reorientation towards the use of natural products in the wake of an emerging sense of *chemophobia* among some consumer groups in industrial countries, the interest in the use of herbal medicine has not only been confined to the material efficacy of 'natural' medicines, but has been extending to include the understanding and application of the underlying traditional philosophies of health, healing, nature and the environment. In addition to these 'hidden' considerations of the reorientation towards natural products, the inability of some modern pharmaceutical drugs to cure several diseases, the reduced risks of

side-effects in many natural products, the generally lower costs, the local availability of several plant resources, and the culturally-appropriateness of the use of specific plant remedies in traditional communities are also playing a significant role.

The historical fact that numerous 'modern' drugs have ethnobotanically been derived from leads that had been known already for so many generations has also contributed to the growing interest and confidence in natural medicinal plants and herbs for health promotion, disease prevention and treatment of disorders. For some people, the use of natural products seems to fill in the gap of modern science regarding its inability to explain the cosmology of the balanced, holistic links between body and mind, the natural world and the spiritual world, and eventually between humans and their universe. Although Western science itself has grown out of reflections upon nature and the universe in order to describe and understand humanity, as Clark (1999) notes: "*…science seems to have forgotten its holistic natural history roots*".

TM: THE CALL FOR INTEGRATION IN DEVELOPING COUNTRIES

While WHO estimates that about 80 % of the world population uses some form of herbal medicine, the majority of the population in developing countries remains fully dependent on the use of traditional herbal medicine for their primary health-care needs (Farnsworth et al. 1985). In view of the difficulties in meeting the need for essential drugs in many developing countries, the revival of interest in traditional medicine (TM) in both developing and developed nations has led to an overall reassessment of the way in which basic health services had been delivered during the late 1970s, prompting WHO (1978) to redefine its strategy of attaining 'Health for All' through the concept of primary health care (PHC). The new strategy, developed at the conference in Alma Ata (WHO 1978), refers to: "*essential health care made accessible at a cost that the country and community can afford*", and is based on the principles of equity, participation, appropriate technology, prevention and an intersectoral approach to public-health problems. Among the programmes that were implemented, the provision of essential drugs, the promotion of health and the collaboration with traditional healers and birth attendants opened up new health policy options for making use of local resources, particularly traditional and herbal medicines.

This new strategy resulted largely from a changing development paradigm that at the same time evolved from a renewed theoretical interest in ethnoscience which sought to operationalize and implement indigenous peoples' ideas and practices in the socio-economic development process. Especially since the early publication of the comprehensive study in this 'new' field of applied-oriented ethnoscience on *Indigenous Knowledge Systems and Development* by Brokensha et al. (1980), the successful incorporation of local knowledge into the health-care development process was later well documented for various cooperation projects and programmes around the globe (Warren et al. 1995).

By consequence, many health-care development programmes were successful in expanding the integration of indigenous medical remedies, perceptions and practices

into the formal health-care systems, not only on the basis of economic considerations, but even more so to invoke a more participatory and sustainable form of integrated health care for the entire population in the country. These include early successful examples such as the 'Primary Health Training for Indigenous Healers Program' (PRHETI) among the Bono people in Techiman, Ghana, focused on further cooperation between Western-trained doctors and nurses and indigenous 'traditional medical practitioners' (TMPs) and 'traditional birth attendants' (TBAs), and the 'Rural Health Development Programme' in Ethiopia, implemented to integrate indigenous Oromo healers into the official health services of the country (Warren et al. 1982; Buschkens and Slikkerveer 1981; McLean 1987).

As a result of these and other empirical studies, WHO then decided to further promote the use of traditional medicine into Primary Health Care in terms of various types of traditional healers and birth attendants, and their indigenous practices in order to contribute to attain a socially and economically productive life of the entire community (cf. Bannerman et al. 1983). More recently, the spectacular efficacy of some traditional MAC plants has further increased the current international interest in their use for both local health improvement and new drug development, strengthening the position of the developing countries as the primary custodians of these natural resources of the tropics (Balick et al. 1996; Slikkerveer 2001).

The increasingly important role that traditional medicine has come to play today in the provision of integrated health care to the community has been well described and analysed by numerous authors over the past decades. Particularly in developing countries where limited resources continue to hamper the equal distribution of scarce modern health care, the potential of less costly and locally available alternative forms of widely used indigenous medical knowledge and practices to contribute to primary health-care delivery is now generally recognized. Supported by international organizations such as WHO and UNICEF, much effort has been made in Africa, Asia and Latin America to their integration into primary health care (PHC) and community-based health care (CBHC) (Warren et al. 1982; Bannerman et al. 1983; Hargono 1998; WHO et al. 1992).

Despite the success of some of the approaches and strategies that were designed for the integration of traditional and modern medical systems, one has to recognize, however, that the related concept of 'HFA/2000' (WHO 1981) has not been realized. Today, a large segment of the rural population in the tropics still remains deprived of adequate health care, which is often only partly based on the incorporation of traditional healing and midwifery. Mainly as a result of the continuing, artificial separation – and sometimes opposition – between biomedicine and ethnomedicine, the envisaged integration as the ultimate result of traditional medical systems negotiating successfully the challenges posed by science and technology is still facing several theoretical and methodological complications which need further study and analysis (Quah and Slikkerveer 2003).

However, recent encouraging examples from the field are further documenting such integration in terms of professional collaboration and mutual referral of patients among traditional healers and biomedicine practitioners, while a number of developing nations have increased their efforts to develop their well-known and tested traditional plant-based medicines in order to extend the services of their

primary health-care centres within the reach of the entire population (Scheinman 1992; Slikkerveer and Slikkerveer 1995; Green 1999).

CAM: THE FALL OF THE 'BAMBOO CURTAIN' IN THE WEST

By the end of the 1990s, a radical change in the Western medical attitude towards alternative forms of medicine was further enhanced by a growing number of publications on the concept of *Complementary and Alternative Medicine* (CAM) in professional medical journals in North America, while at the same time numerous health-care agencies started to assess the integration of various forms of CAM into their services (Freeman and Lawlis 2001). Indeed, the significant article in 1997 of the dramatically rising number of articles on CAM in the prestigious *Journal of the American Medical Association* (JAMA) by its Editor, Dr. George Lundberg heralded the fall of the 'Bamboo Curtain' between alternative and conventional medicine in the West. His historical announcement that within the year an entire volume of the Association's flagship journal would be devoted to scientific studies and editorial content on CAM indicated that the 'curtain' was indeed 'beginning to splinter'.

The concept of CAM is defined by Vickers (2000) as: "*a broad domain of healing resources that encompasses all health systems, modalities, and practices and their accompanying theories and beliefs, other than those intrinsic to the politically dominant health system of a particular society or culture in a given historical period*". As such, it refers basically to the integration of alternative therapies (herbal medicine, chiropractic, acupuncture, homoeopathy and massage), alternative professionals practising these disciplines, complementary self-help strategies, as well as alternative philosophies of health and healing such as energetics, spirituality and distant healing.

Despite the sporadic attribution from a conventional medical point of view to CAM as being 'unscientific', the outcome criteria of alternative-therapy assessment by patients clearly indicate its positive contribution to comprehensive health-care delivery. One of the major, fastest growing elements of these alternative therapies in the United Sates includes herbal medicine, the use of medicinal plants for health and healing purposes (Eisenberg et al. 1998). As mentioned before, these Western herbal medicines are in contrast to modern drugs made up of whole plants or their parts including bark, seed, leaves, fruits, roots or stems, often produced as pills or capsules, or as teas or tinctures.

The evaluation of such alternative therapy programmes has raised some relevant issues including a particular methodology to measure the outcome criteria on both the individual and the system levels. The outcome criteria at the individual level of clients and patients are generally applied to the experience and perceptions of the participants of the programme. In addition to obvious criteria including pain reduction and vocational rehabilitation, as Freeman and Lawlis (2001) note, a number of specific outcome criteria have been developed, including: (1) energy and activity levels; (2) functional abilities; (3) sleep and eating behaviour; (4) disease symptoms; (5) health status; (6) satisfaction with health (or health service delivery); (7) sex life; (8) well-being; (9) psychological effects (i.e. increased positive features,

such as self-esteem, self-control and/or decreased negative features, such as anxiety, stress); (10) life satisfaction; (11) happiness; (12) ability to work; and (13) employment status.

This process had been preceded by similar trends in Western Europe – notably Belgium, Germany and The Netherlands – where specific forms of alternative medicine have been integrated into formal health services since the late 1970s. In these countries, expert committees had been established to define and describe alternative and herbal medicine, and to provide safety and efficacy control of phytomedicines. In this way, standardized information has been collected on the plant species, including: a) the description; b) pharmacology; c) usage; d) doses; e) toxicity; and f) side effects, usually completed with indications, contra-indications and potential drug interactions. Among the most popular medicinal herbs well-documented in the literature are bilberry, cranberry, *Echinacea*, feverfew, *Ginkgo biloba*, goldenseal, kava kava, milk thistle, saw palmetto and St. John's worth.

A similar approach of 'integrative medicine' (IM) has recently been developed to bring together modern medical science and traditional health systems, focusing on the interaction of systems of the individual level from a holistic point of view. In addition to the use of non-conventional therapies, integrative medicine also seeks to evoke changes in lifestyle for improved health and well-being of the population (Peters and Woodham 2000). In recognizing the wholeness of humanity as individuals, as groups and as a planetary whole, such holistic approach to health care is also reflected in 'holistic herbalism' (HH) which includes the understanding and treatment of patients within the context of their entire culture and community. Focusing on the use of healing plants, HH also seeks to strengthen the relationship between orthodox and complementary medicines in order to develop a new kind of holistic health service (Hoffmann 1996).

While the market value of the plant-based prescriptions filled in the United States was initially estimated by Farnsworth et al. (1985) to exceed $ 8 billion in 1980, such value of both prescription and over-the-counter drugs based on plants for the OECD countries was later estimated by Principe (1989) at about $ 43 billion in 1983. The estimation of the contribution of plant-based medicines to medicine and the pharmaceutical industry basically refers to their economic value, which adds to their market value of sales: (a) the value of decreases in morbidity or mortality as the result of their use; and (b) the value of their contribution to public health.

Taking in this way only the benefits into account that are derived from saving lives of people with cancer, the economic value of plant-based anti-cancer drugs in the USA was estimated in 1989 to be $ 250 billion annually, a value that had increased by 1996 to about $ 5 trillion (Principe 1996).

Together with the recent consumer-driven explorations of health-care institutions in Western countries into 'alternative' medicine, these recent developments form a prelude to a world-wide process of integration into a new syncretic, pluralistic health-care system that will further develop over the next decades (Freeman and Lawlis 2001). In this process, the contribution of alternative and traditional medicine as innovative wisdom to science and technology has to be further documented, analysed and understood, especially in view of the current threat of its extinction as part of the rapidly vanishing indigenous cultures around the globe.

THE TRIAL OF EXPERIMENTAL VALIDATION

Although the patterns of use and exchange of well-tested medicinal plants between bio- and ethnomedical systems are actually reflecting a certain degree of integration in the clinical setting in the field, the 'scientific' validation and formal approval of these often complex traditional remedies for application in modern health care has remained rather problematic. Not only include such 'scientific' validation techniques a series of protracted, time-consuming laboratory activities such as extraction, screening, isolation and structural determination of lead compounds, but they are often also confronted with extremely high costs and lengthy administrative procedures that eventually may pertain to official approval (Balick 1994; Cox 1994; Farnsworth 1994; Heinrich and Gibbons 2001).

By consequence, the venture of new drug development by pharmaceutical companies – also known as pharmaceutical prospecting – usually involves a long-term investment with high risks and few commercial yields. For example, a study on drug development at the Merck pharmaceutical company documents that for every 10,000 substances that are evaluated through bioassays, only 20 are selected for additional animal testing. Out of these 20 substances, 10 are evaluated in humans, and only one will eventually be approved by the Food and Drug Administration for sale as a drug in the US. The whole process requires about 12 years and costs $ 231 million (Vagelos 1991). Thus, this approach to drug development on the basis of substances that are primarily synthetic in origin can only be afforded by the largest drug companies. Recently, Lans (2001) has estimated that the cost of conventional validation has become so high that only large drug companies with sales over $ 5 billion can afford to engage in drug discovery projects.

However, as many useful drugs have been derived from higher plants to provide medicines for the world's population, health care and botany have been closely related in the search for new plant-based medicines (Figure 3; see colour pages elsewhere in this book). As Farnsworth (1994) documents, about 75 % of the 119 secondary metabolites, identified and described in 1985, that were isolated from about 90 higher plant species used as drugs, represent 'prototype drugs' which continue to be used as medicines such as, e.g., atropine, morphine, codeine, pilocarpine, reserpine and vinblastine. Given the estimated 250,000 species of higher plants existing today around the globe, more plant species could be discovered to possess bioactive components for the development of new drugs.

Indeed, specifically in the search for anticancer agents, the United States National Cancer Institute (NCI) has increasingly focused on the pre-clinical screening of natural materials and products, including plant collections fro m around the globe. In addition to the conventional method of random sampling, which is based on the collection of all higher plant species found in a particular research area, phylogenetic targeting has been used to collect and identify all members of certain plant families that already have shown to possess significant bioactive compounds.

Despite major advances recently made in the experimental validation of plant materials, the process has basically remained complex, costly, risky and time-consuming, rendering the contribution from related disciplines justified and worthwhile.

PROGRESS OF THE 'ETHNO-DIRECTED APPROACH'

The medical anthropological and ethnobotanical literature has also contributed useful information on the pharmaceutical value of many plant species used by indigenous communities, including a large number of studies documenting that from the *emic* perspective of healers and their patients, several traditional therapies have shown to provide rather satisfactory treatment and cure. These therapies are often based on the knowledge and use of local medicinal plants and herbs, rendering adequate care to such conditions of dislocated joints and broken bones, chronic diseases, gastrointestinal illnesses, child birth complications, mental disorders and cultural-bound syndromes which potentially could contribute to the formation of an alternative, less costly and culturally more appropriate system of health-care delivery (Bannerman et al. 1983; Warren 1989; Buschkens 1990; Lewis and Elvin-Lewis 1994; Slikkerveer 1990; Arvigo and Balick 1993; King and Tempesta 1994; Balick and Cox 1997; Milliken 1997; Lefeber and Voorhoeve 1998; Posey 1999; Quah and Slikkerveer 2003).

Based on this information, a more successful method in bio-prospecting has been developed, known as the ethno-directed sampling of indigenous plant collections on the basis of traditional knowledge and practice of medicinal plant use by traditional healers and their patients. Comparison of results from random sampling for plants with bioactive components has shown that ethno-directed sampling provides a comparatively greater proportion of useful plants (Balick 1994; Cox 1994; Farnsworth 1994). Similarly, the enormous input of these research activities focused on diseases which are gradually becoming a threat to the world population, such as cancer, malaria and HIV/AIDS, has also included the ethno-directed approach to increase the chance of identification of leads.

As a result, the use of traditional botanical knowledge as a promising instrument in bio-prospecting for useful plants for medicine, food and fibres has recently increased, rendering ethnobotanical research methods and techniques rather contributive to the experimental validation and development of new plant-based products. Thus, numerous ethnobotanical studies have recently been conducted with the objective to identify new pharmaceutical products, rendering medical ethnobotany a useful tool in the search for new drugs.

Depending on the type of research focus – fundamental or applied – various approaches have further been developed and tested in ethnobotany to document and analyse people's knowledge and practice concerning the use and management of their plant resources. Martin (1995) refers to four major ethnobotanical endeavours: (1) basic documentation of traditional botanical knowledge; (2) quantitative evaluation of use and management of botanical resources; (3) experimental assessment of plant-derived benefits for subsistence and commercial purposes; and (4) applied projects that seek to maximize the value of ecological knowledge and resources for the local people.

Lewis and Elvin-Lewis (1994) have suggested that the first three approaches would encompass three interrelated phases of future ethnobotanical research: basic, quantitative and experimental ethnobotany. While basic ethnobotany refers to the descriptive compilation and organization of information on indigenous-peoples'

knowledge on useful plants and animals, their local classification systems and their management practices, quantitative ethnobotany goes a step further to develop methods and techniques for the quantitative description, evaluation, analysis and comparison of primary data sets (Prance 1991). Experimental ethnobotany involves the use and analysis of biota for the development of medicines and other natural products for industrial and other commercial purposes.

However, despite the advancement in interdisciplinary research methods and techniques in the ethno-directed search for new drugs, conventional validation of bioactive components in traditionally used plant species still remains very costly and risky. Among the factors that lead to such high costs is the local practice of use of multiple plant mixtures in traditional medicine. Instead of isolating the single plant species in validation, the actual plant mixtures should also be included, as complex chemical interactions take place among bioactive components of single plants and in plant mixtures. Similarly, preparations of mixtures of plants can either increase the activity of compounds or diminish toxicity (Etkin 1993).

ADVANCES IN NON-EXPERIMENTAL VALIDATION

In general, the methods to establish whether a local remedy, practice or technology works in terms of efficacy, effectiveness and variability are based on a comparison with Western, scientific technologies. Although such applied-oriented approach has only partly been successful to validate only specific – often empirical – components of indigenous knowledge systems such as medicinal plants with the help of Western-derived parameters in a 'scientific' way, it has been less satisfying in the identification of such 'invisible' albeit significant factors as local perceptions, beliefs and attitudes as part of the cosmology of the community involved.

The specific field of ethnobotany as the multidisciplinary study of interactions between people and plants involving contributions from botany, ethnopharmacology and anthropology, as well as from ecology, economics and linguistics, builds on different methodologies developed to study and analyse these indigenous phenomena in a particular culture or community in a cross-cultural way. Some of the related medical ethnobotanical studies have accumulated evidence of indigenous herbal remedies as possessing significant empirical physiological effects which rule out the possibility that these effects result from symbolism, magic or the placebo effect (Dobkin de Rios 1972; Herrick 1983; Moerman 1983; 1991). These studies indicate that indigenous knowledge and experience substantiating the culturally perceived empirical efficacy of indigenous remedies seem to be directly related to the selection and use of medicinal plants by the local people (Trotter and Logan 1986).

Attempts in ethnomedicine and ethnopharmacology to validate plant-based medicines on a non-experimental basis have sought to embark on more realistic considerations of cross-cultural comparative studies of human physiological processes, the way in which these processes are perceived and the culture-specific patterns of behaviour which are largely based on these perceptions.

Initially, as Lans (2001) describes, a set of systematic procedures had been developed in the late 1980s to assess the empirical validity of herbal medicines in local communities, involving: (1) obtaining an accurate botanical identification; (2) determining the extent to which the folk medicinal data can be understood in terms of bioscientific concept and methods; (3) searching the chemical/pharmaceutical literature for the plant's known chemical constituents; (4) searching the pharmacological literature to determine the known physiological effects of either the crude plant, related species, or isolated chemical compounds that the plant is known to contain; and (5) comparing the medicinal effects known to bioscience with the effects users in the study community seek in order to assess their congruence and the nature of disagreements when they occur (Browner et al. 1988; Heinrich et al. 1992).

This method was later extended by a *sixth* technique regarding the assessment whether the plant use is based on empirically verifiable principles, for instance, if the plant is reputed to cause itching or bleeding, the *etic* assessment will determine if it contains chemical constituents that are capable of causing itching and bleeding, or, whether symbolic aspects of healing (or hypnosis, social support, placebo) are of greater relevance (Heinrich et al. 1992). More recently, Heinrich (Heinrich 2001) points to the application of a combination of general ethnobotanical and ethnopharmacological methods with specific anthropological and botanical methods. Indeed, in the field of ethnobotany as the multidisciplinary study of interactions between people and plants that involves contributions from botany, ethnopharmacology and anthropology as well as from ecology, economics and linguistics, different methods have been developed to study, analyse and compare indigenous botanical knowledge and use of plants in a particular culture or community. By consequence, various studies reflect such multidisciplinary orientation in research methodology in ethnobotany.

While Given and Harris (1994) developed a practical manual for techniques and methods of ethnobotany and Alexiades (1996) formulated appropriate guidelines for ethnobotanical research, Heinrich et al. (1998) underscore in a recent comparative study on medicinal plant use in Mexico the importance of a standardized methodology that would allow for such intercultural comparison among different groups. Although these methods attempt to disengage from the dominant Western scientific paradigm, and develop cross-cultural ethnomedical and ethno-pharmacological research methods, they remain largely plant species-centred and biochemical-activity-oriented, still confirming the conventional long-term and costly pharmaceutical prospecting and validation process.

TRANSCULTURAL UTILIZATION OF MAC PLANTS

A specific domain in the critical interaction process between ethno- and biomedical systems encompasses the cross-cultural exchange and use of traditional plant-based medicines that goes back to the early days of the first cultural contacts between Western and non-Western communities. Later, during the Renaissance, the flourishing of Western botanical knowledge did not merely emerge from the proto-scientific, regional European knowledge systems, but was enriched by the incorporation of the knowledge of medicinal plants and herbs used in other cultures in the Middle-East, Asia and the Americas to substantiate the *Materia Medica* in Western Europe.

Moreover, many species of useful plants were sought after and imported from overseas cultures for therapeutic use to contribute to the development of cosmopolitan medicine and the improvement of health care in the West. Thus, the formative period of modern botany and pharmacology in Europe in the 16th century was founded on early botanical and medical knowledge developed largely from the ethnographic study of traditional knowledge and use of medicinal plants and herbs in non-Western cultures in the tropics (Ellen and Harris 1999; Slikkerveer 2000).

However, in today's academic arena of the medical social sciences, particularly medical anthropology and sociology, the dichotomy that later developed between biomedicine and ethnomedicine has continued to cast a shadow over various attempts to describe, analyse and possibly integrate both medical systems in a comparative mode. As Cotton (1996) notes: "*despite the growing body of knowledge which underscores the empirical validity of the use of traditional therapies and medicaments, mutual misunderstanding across both cultural and scientific boundaries seems to persist*".

A major issue in the current debate refers to the methodology to encapsulate the particular socio-cultural context of health and disease which, in essence, explains why people from distinct cultures tend to react differently to the same symptoms of disease and, by consequence, show a differential pattern of utilization of various medical systems. Such methodology would bring back the human dimension in human-plant relations and interactions, and is crucial to contribute to the envisaged multiple research methods. In an effort to bring the different medical systems together, simple projections of indigenous medical phenomena were initially cast onto a biomedical screen, and attempts were made to establish a universal validity of traditional medicines and practices according to Western biomedical standards. However, these and similar endeavours remained rather normative, using Western 'scientific' interpretations as the ideal if not ultimate standard for comparison. In order to examine the complex medical configurations in most developing countries within their own historical-cultural context, it was Leslie (1976) who introduced the useful concept of medical pluralism that has enabled researchers to examine complex health-care systems and their functionaries in a more realistic way.

Particularly in the practical setting of pluralistic configurations of co-existing local, regional and cosmopolitan medical systems prevailing in most developing countries – where the absence of adequate modern services to a certain extent has

allowed for the persistent utilization of a variety of traditional therapies as part of the local culture – the use of indigenous medicinal plants and herbs has lately attracted the increased attention of scientists, policy makers and the general public. Over the past decades, the above-mentioned research on the use of medicinal plants in developing countries has developed from monocultural studies to the intercultural comparison of the use of local plants and herbs.

Initially, patterns of medicinal plant use have mainly been studied and analysed on the basis of the role that these plants generally play in one, often traditional culture or community (Friedman et al. 1986; Sindiga 1994; Heinrich 1996). This monocultural approach, which sometimes has tended to highlight the exotic elements in non-Western healing practices of one ethnic group, has unintentionally contributed to the criticism that indigenous ethnobotanical knowledge is largely context-determined, qualitative and spiritually-based. Later attempts that link up with the comparative approach, well developed in medical anthropology, have sought to embark on more realistic considerations of cross-cultural studies of human physiological processes, the way in which these processes are perceived and the culture-specific patterns of behaviour that are based on these perceptions (Browner et al. 1988; Slikkerveer 1990; Heinrich et al. 1998). Some of these studies compare the utilization of medicinal plants among various cultures or communities, not only providing significant information on the relative importance of a specific medicinal plant within one culture, but also analysing their use among different cultures (Heinrich et al. 1992; Etkin 1993; Moerman 1996; Heinrich et al. 1998).

Although these studies manage to provide an empirical, less normative assessment of traditional medicinal plants used for different types of diseases by various peoples living within the same cultural area, documenting both intra- and intercultural patterns of use, they are still carried out within one medical – often traditional – system as if no other – transitional or modern – medical systems are operational in the region. By consequence, these studies could be regarded as inherently isolationistic since virtually very few ethnic groups around the world today do not have some, albeit often very limited, access to any form of cosmopolitan medicine. Indeed, patients have shown to engage in 'healer shopping' to seek different therapies and medicines for the same illness or disease.

Moreover, health-care utilization research has shown that in plural medical configurations, the availability of different co-existing forms of traditional local and regional, and transitional and modern medical systems also influences the choice of therapy and the related use of medicines (Janzen 1978; Kroeger 1983; Slikkerveer 1990). As is indicated below, the newly-developed approach of ethnobotanical knowledge systems (EKS) not only reveals the concurrent, shared use of specific medicines among different medical systems – substantiating the 'common ground' among traditional and modern systems – but also underscores the need to assess the role of the different factors or clusters of factors involved in the overall health-care utilization patterns (Alcorn 1995; Quah and Slikkerveer 2003).

Given the above-mentioned international resurgence of interest in the knowledge and use of medicinal plants within such plural medical configurations in developing countries, special attention should be given to the study of transcultural utilization of plant-based medicines by patients between and among different traditional,

transitional and modern medical systems, operational within one culture or community. Since such interest in the use of traditional MAC plants is also inspired by the need of novel biochemical compounds for the development of drugs against 'new' diseases, validation of these plants has become a major step in the entire process of pharmaceutical prospecting ranging from collection and identification of biotic samples and the related indigenous knowledge through pharmaceutical research and development to the final industrial production of new drugs. Here, the multiple research methods in non-experimental validation for new plant-based drug development has to be further developed and extended by useful information on a series of interacting 'hard' and 'soft' factors determining the ultimate use and efficacy of particular MAC plants in different cultures.

OVERALS: THE MULTIVARIATE MODEL AND ITS COMPONENTS

In the continuum of the 'knowledge–belief–practice' complex used to study, analyse, understand and predict patterns of human utilization behaviour of MAC plants in conjunction with the interacting variables, three major analytical phases are involved: bivariate, multivariate and multiple regression analysis. After the identification, collection and organization of the different qualitative and quantitative data, the choice of application of statistical analysis is influenced by the research interest of the study. A simple statistical analysis, in which a data matrix is constructed with objects as rows and variables as columns as the basic linear technique to relate the first and the second data set is called a 'bivariate correlation analysis'. This technique not only reveals possible interaction between one independent variable – for instance perceived morbidity (PM) – with one dependent variable – for instance the use of a particular plant species – but also determines if such relationship is significant.

In order to measure the interaction among different variables, however, non-linear correlation analysis has to be conducted through the use of multivariate analysis. Among the most common multivariate analysis techniques are the basic correlation analysis to measure the general relationships among variables, cluster analysis to assess similarities or dissimilarities among variables, principal-component analysis to determine variance among variables, and regression analysis to establish quantitative relationships among variables and prediction. The latter regression analysis allows for predicting values of dependent variables from a group of explanatory, independent variables, and is as such appropriate for the explanation and prediction of behaviour as a dependent variable from a group of independent background, i.e. predictor variables. In addition, multiple regression models also encompass measurements of interactions between and among variables.

For the measurement of the predicting value of different sets (or 'blocks') of background variables in interaction with each other and with a set (or 'block') of intervening variables, the choice of a non-linear correlation analysis has the advantage that it is a technique that may lead to different solutions from different starting points (Van der Burg 1983). In this application, the selected multivariate analysis is able to cover all the variables in the survey without discriminating

between variables or 'blocks' of variables, and allows for drawing conclusions on correlation, interaction and predictability using the canonical correlation analysis of the total number of variables. However, if an explanatory model of utilization behaviour of MAC plants has to be developed, multivariate analysis should be used to examine the correlation among 'blocks' of independent background variables with the 'blocks' of dependent utilization behaviour variables of these plants in the model.

Although such model could also be developed as a pathway model using a linear partial canonical correlation analysis, a non-linear correlation analysis (OVERALS) is preferred as it increases the predicting value on MAC plant utilization behaviour by respondents in the survey from an increasing number of background and intervening variables. This analysis, recently developed by the Department of Data Theory of Leiden University has the advantage not only to identify specific factors as significant determinants of utilization behaviour in a given configuration, but also to measure the relative strength of these determinants within the context of the interactive processes involved.

The model of MAC plant utilization behaviour, in which the calculated correlation coefficients can be indicated separately, could be constructed on the basis of the position and interaction among 'blocks' of various groupings of independent, intervening and dependent variables, as shown in Figure 4.

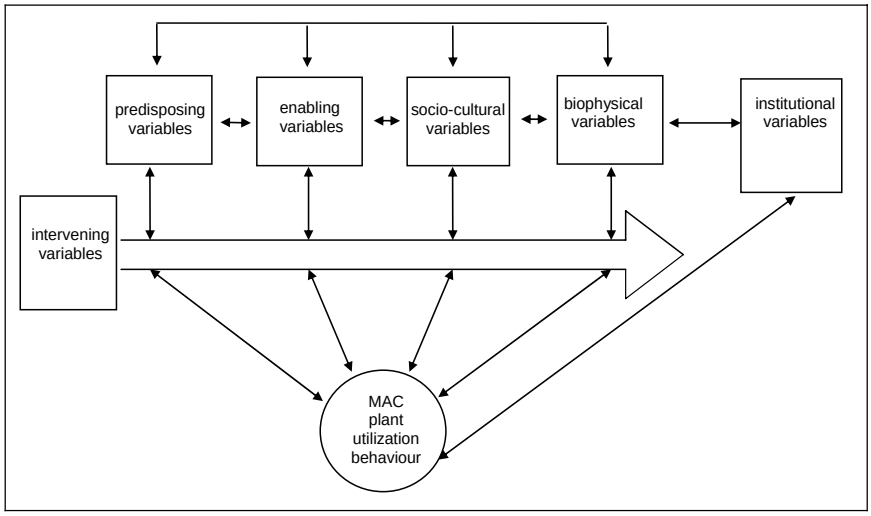

Figure 4. *Multivariate model of MAC plants utilization behaviour.*

The categories of independent socio-demographic, psycho-social, socio-economic, biophysical and institutional variables, as well as the intervening and dependent variables of MAC plant utilization behaviour are listed in Table 1.

Table 1. *Blocks of variables and related factors introduced as components into the multivariate model of MAC plant utilization behaviour*

Level of analysis	Socio-demographic factors	Psycho-social factors
Independent variables at the individual level	Sex, age, education, religion, ethnicity, profession, marital status, household size	Knowledge, beliefs, perceptions, attitudes, opinions, values, satisfaction, experience
	Enabling factors, tools, utensils, household budget	SES, family income, type of house, area of land, livestock
	Socio-cultural factors, taxonomies, classifications	Plant use-values, norms, myths, taboos, cosmovisions
Independent variables at the system level	Bio-physical factors, habitats, ecozones	Plant species/resources, vegetation types, rainfall, altitude, soil types
Institutional factors	Administrative representations	Local and national structures, local institutions and organizations
Intervening variables	Factors of health-care policy, government policy, commercial activities and bioprospecting laws, regulations, controls	Government policy planning and implementation, commercial logging, migrants, globalization, mass media
Dependent variables	Factors of MAC plant utilization behaviour	Patterns of transcultural MAC plants utilization behaviour

In this model, additional, object-specific variables can be introduced for analysis in relation to the experience of the individuals in the sample surveys, such as pain reduction, perceived energy and activity levels, sleep and eating patterns, disease symptoms, satisfaction with medicines, perceived health and well-being, and ability to perform daily tasks.

In the final analysis, the outcome variable of MAC plant utilization behaviour of the model could be matched in a complementary way with the results of the above-mentioned six qualitative research methods ranging from accurate botanical identification to the assessment whether plant use is based on empirically verifiable principles or symbolic aspects of healing. In turn, promising leads to such potential MAC plant species could undergo elementary tests of safety and efficacy through

toxicity and hygienic tests. In this way, the complementary qualitative and quantitative multiple research methodologies together could further strengthen the non-experimental validation of traditional MAC plants for both new drug development and biodiversity conservation.

CONTRIBUTION OF 'ETHNOBOTANICAL KNOWLEDGE SYSTEMS'

In view of the increasing scarcity of ethnobotanical information from intact indigenous peoples as the result of the ongoing loss of bio- and cultural diversity on the one hand and the growing attention for the dynamic processes of acculturation and transculturation among communities that incorporate both non-Western and Western forms of knowledge and practices on the other hand, a more realistic view is reflected in the development of the comparative approach of Ethnobotanical Knowledge Systems (EKS). Based on a general indigenous knowledge systems' perspective, the newly-developing field of EKS focuses on the knowledge and use of plant resources within and among different cultures and communities within a particular field of anthropological study (FAS) (Slikkerveer 2000; Quah and Slikkerveer 2003). As Alcorn (1995) notes, such resources not only include plant knowledge, belief and practices, plant-related technologies, locally adapted crops, agricultural and forest systems, farming values and strategies, and ecological principles, but also information about local constraints, opportunities and needs.

Linking up with such cultural-relativist research strategy to assess traditional herbal medicine within and among different cultures and communities, it could provide a comparative perspective on non-experimental validation on the basis of the feedback of complementary knowledge, perceptions and practices of MAC plants by clients and patients. In this way, a relatively rapid, less costly methodology of identification and validation could be developed by bringing in the human dimension in the human–plant interactions in plant-based medicine.

Embarking on the EKS approach, the complementary methodology of non-experimental validation (NEV) is being developed in co-existing medical systems and sub-systems, implementing a multivariate analysis of related quantitative factors and variables involved in the knowledge, perceptions and utilization of MAC plants.

Such method of quantification of data not only increases the explanatory and predictive value of data, but in the related multivariate analysis, such 'subjective' individual factors of perceptions, cosmologies and belief systems are statistically transformed into 'objective' system variables for analysis that eventually will enhance the applicability of the outcome variables for improved non-experimental validation of MAC plants in a cross-cultural way.

This quantitative approach is also supported by current efforts to increase the mutual understanding between global and local knowledge, where a number of ethnobotanists – in collaboration with local peoples and extension agents – focus to achieve further integration and synergy among these systems in a variety of ways. In addition to the conventional descriptive methods to record local classifications and uses of plant species, recent developments in data collection and analysis have taken

ethnobotanical research methodology into advanced qualitative and quantitative approaches (Martin 1995; Minnis 2000; Slikkerveer 2001).

As mentioned before, Lewis and Elvin-Lewis (1994) suggested that these approaches refer to three interrelated phases of future ethnobotanical research: basic, quantitative and experimental ethnobotany. Particularly, recent advances in quantitative ethnobotany attempt to improve the field of study by introducing and extending quantitative methods in both data collection and interpretation of results, to which the above mentioned model seeks to provide its contribution.

Prance (1991) introduced this new approach back in 1987, and it has later been defined by Philips and Gentry (1993a; 1993b) as: "*the application of quantitative techniques to the direct analysis of contemporary plant use data*". While, in general, quantitative methods and techniques strengthen the indicative and predictive value of factors or variables in ethnobotanical research, they also allow for cross-cultural comparison of data between and among different ethno-linguistic groups and communities. In this way, increased understanding of phenomena and processes will also contribute to improved resource conservation and sustainable community development.

Since quantitative analysis depends to a large degree on the availability and reliability of quantitative field data, refinement and extension of data collection methods and techniques have similarly attracted the attention of ethnobotanists. This has resulted in the development of a variety of methods, ranging from structured and semi-structured interviews, participant observation, household surveys, various forms of comparative techniques, structured interactions and analytical tools. It includes specific data-collecting techniques to compile an ethnobotanical data set of the research area such as plant collections, local classification systems, socio-demographic information, indigenous botanical knowledge and use and management behaviour of participants. The use of analytical tools has increased the compilation of detailed quantitative data on specific subjects, and involves the use of preference ranking, matrix ranking, paired comparisons and triad comparisons (Martin 1995).

A similar transcultural orientation is used in the current study of MAC Plants in Indonesia, Kenya and Tanzania. In this approach, attention for local knowledge and experience with basic properties of toxicity and side-effects of plants is complemented by information related to the characteristics of the MAC plant users themselves, i.e. the local healers and their clients/patients (Slikkerveer 2000; Quah and Slikkerveer 2003).

The EKS approach encompasses a combined research interest in both material and immaterial MAC plant-related data, including local knowledge, perceptions, beliefs, practices, plants, seeds, crops and related artefacts. To this end, the 'Leiden Ethnosystems and Development Programme' (LEAD) of Leiden University has developed the multivariate model to analyse, explain and predict the EKS of comparable communities by studying the knowledge, belief and use of MAC plants for a complex of reasons, such as to contribute to:

- local and global health promotion and health-care improvement;
- conservation of biodiversity, in terms of genes, species and ecosystems;

- conservation of cultural diversity in terms of related knowledge, belief, perceptions and practices; and
- recognition of local rights of intellectual property and natural resources

In its implementation, this research strategy is based on the principles of local participation and stewardship, the indigenous right of self-determination, joint agreement and protocols, equal sharing of potential benefit, and compliance with international ethics and codes of conduct.

CONCLUSION

Following an overview of recent processes and developments conductive to the introduction and recognition of the human dimension in global health-care improvement in terms of the rediscovery and integration of herbal medicine into more integrative forms of health-care systems, a description is given of the sequence in the search for new drugs from experimental to non-experimental validation, pertaining to the documentation of recent achievements in the field of medical ethnobotany and ethnomedicine.

In order to provide a contribution to the multiple research methodology recently designed to increase the identification and validation of MAC plants for new drug development from an ethnobotanical/anthropological perspective, a quantitative model is presented that attempts to underscore the response to current challenges of experimental validation of indigenous medicinal, aromatic and cosmetic (MAC) plants. In particular, the complementary approach to apprehend the pharmaceutical value of these plants as major components of traditional medical systems – presently experiencing a resurgence in interest – provides a method of non-experimental validation (NEV) to assess the transcultural usefulness of these plants and herbs among different systems on the basis of a wide variety of variables being collected and analysed at both the individual and the systems level in defined cultural areas.

The preliminary assessment of the possible advantages of this model, as it introduces an analysis of a wide range of different quantitative variables involved, is that it adds value to the understanding and prediction of both the utilization of MAC plants and their potential for new drugs, as well as of the impact of outside interventions such as external commercial activities, pharmaceutical prospecting or the introduction of formal medical practices into the pluralistic medical configuration.

In such endeavour, the various approaches to study the complex interactions between variables of knowledge, perceptions and practices in relation to MAC plant utilization behaviour not only focus on the qualitative methodologies so far developed, including symbolic analysis of ritual and myth, the structural analysis of social organization and research of local classification systems, but also includes quantitative techniques that would elevate ‘subjective’ variables at the individual level, such as complex perceptions, cosmologies and belief systems, to ‘objective’ variables at the systems level which can be regarded as specific cultural features of the local community in the research area. Such broader range of factors included in the analysis will provide relevant information not only on the local priority plant

species list, but also on outcome criteria on both the individual and the system levels. These include the people's considerations for using particular plant-based medicines in a special mode – on the basis of either one or more species – for specific disorders, their perception, experience and satisfaction, as such providing a promising complementary contribution to the multiple validation process of MAC plants for improved health care for peoples and communities around the globe.

In the final analysis, the outcome variables of local MAC plant utilization in a transcultural setting of bio- and ethnomedical systems will provide an alternative of improved non-experimental validation of medicinal plants that paves the way for further integrated health-care development.

While the main theoretical implications refer to the significance of both the *emic* view in the study of indigenous plant use knowledge and practice, and the importance of the role the human dimension in human–plant relations can play in the search for new medicines, the methodological contribution is encapsulated in the complementary orientation towards experimental and non-experimental validation as another step in the development of multiple research methods concerning the knowledge and use of MAC plants. Since the model embarks on the systems approach of human behaviour, facilitated by the statistical transformation of data from the subjective to the objective systems level, it also underscores the usefulness of the biocultural systems approach towards both plant use and conservation behaviour.

Since the contribution of the multivariate model to the non-experimental validation process is based on the principles of the newly-developing field of quantitative ethnobotany, it is hoped that the resulting increased strength of the predictive value of research findings will eventually support the non-experimental validation methods for the development of new drugs for the benefit of peoples and cultures around the globe.

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NOTES

[1] The neologisms *emic* and *etic*, which were derived from an analogy with the terms 'phonemic' and 'phonetic', were coined by the linguistic anthropologist Kenneth Pike (1954). He suggests that there are two perspectives that can be employed in the study of a society's cultural system. In both cases, it is possible to take the point of view of either the insider or the outsider. The emic perspective focuses on the intrinsic cultural distinctions that are meaningful to the members of a given society (e.g., whether the natural world is distinguished from the supernatural realm in the worldview of the culture). The etic perspective relies upon the extrinsic concepts and categories that have meaning for scientific observers (e.g., per capita energy consumption). (adapted from James Lett's web site).

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