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Egyptian Herbal Drug Industry: Challenges and Future Prospects

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ABSTRACT

According to the World Health Organization (WHO), the goal of Health for All cannot be achieved without herbal medicines. While, the demand for herbal medicines is growing in developing countries including Egypt, there are indications that consumers in developed countries are becoming disillusioned with modern healthcare and are seeking alternatives in traditional medicines. There is, therefore, an increasing consumer demand for herbal medicines in developed countries. Medicinal plants have been used as a source of remedies since ancient times in Egypt. Many plants are still used today in folklore medicine and are sold at herbal vendors and shops. Egypt is characterized by abundant production of medicinal and aromatic plants that are exported all over the world and is considered as one of the most important sectors can be relied upon to increase the volume of Egyptian exports due to the growing global demand but several factors pose constraints to their entry into the international market and put them in a disadvantageous position. This review article explores the situation of the Egyptian herbal drug industry, the economic value, the needs and recommendations for developing this important sector.

Key words: Herbal medicines, challenges, drug industry

INTRODUCTION

Medicinal plants have acquired increasing significance in development co-operation over the last few years. Their use and conservation are cross-sectoral concerns that embrace not only health-care but also nature conservation, biodiversity, economic assistance, trade and legal aspects (e.g., intellectual property). Even today, the majority of the world's population is dependent upon traditional medicine and thus also on the use of plants and plant extracts. This is particularly true of poorer sections of the population in developing countries, because natural remedies are not only cheaper than modern medicines but are often the only medicines available in remote rural regions.

According to the WHO, 80% of the world's population is dependent on health-care provided by medicinal plants. The use of traditional medicine and medicinal plants in most developing countries, as a normative basis for the maintenance of good health, has been widely observed (UNESCO, 1996). Furthermore, an increasing reliance on the use of medicinal plants in the industrialized societies has been traced to the extraction and development of several drugs and chemotherapeutics from these plants as well as from traditionally used rural herbal remedies (UNESCO, 1998). Moreover, in these societies, herbal remedies have become more popular in the treatment of minor

ailments and also on account of the increasing costs of personal health maintenance. Besides serving medical and cultural functions, medicinal plants in developing countries have an important economic role. But the economic importance of medicinal plants extends far beyond the national markets in developing countries. The sustainable purchase of plant-material can therefore considerably improve trade-balances in the countries of origin and offers major potential in terms of development. The basis for this is the unique biodiversity that exists in the developing countries, where 90% of the earth's genetic diversity is to be found. Indeed, the market and public demand has been so great that there is a great risk that many medicinal plants today, face either extinction or loss of genetic diversity. Due to less communication means, poverty, ignorance and unavailability of modern health facilities, most people especially rural people are still forced to use medicinal plants for their common day ailments (Harbir, 2006).

Also and according to the World Health Organization (WHO), the goal of Health for All cannot be achieved without herbal medicines. While the demand for herbal medicines is growing in developing countries including Egypt, there are indications that consumers in developed countries are becoming disillusioned with modern healthcare and are seeking alternatives in traditional medicines. There is, therefore, an increasing consumer demand for herbal medicines in developed countries. For example, in Germany the value of prescriptions written for the anti depressant St. John's Wort is twice that for Prozac, a top selling antidepressant. The increasing demands for herbal medicines by consumers in both developing and developed countries, has renewed interest by the multinational pharmaceutical industry in bio-prospecting. But the lack of national legislation or effective international agreements on conservation and sustainable use of bio-diversity has resulted in slaughter harvesting of medicinal plants and massive depletion of biodiversity. Further, the lack of coordination has also led to critical research gap, that is, there is a regrettable absence of any research community working on socioeconomic and policy aspects of medicinal plants, such as that which exists with regard to agro technology, biotechnology etc. In fact, scientists working in natural sciences themselves conducted socio economic research in medicinal plants resulting in generally unprofessional analysis leading to over simplification of complex issues and providing very general suggestions to tackle socioeconomic issues.

HERBAL MEDICINE IN EGYPT

Medicinal plants have been used as a source of remedies since ancient times in Egypt. The ancient Egyptians were familiar with many medicinal herbs and were aware of their usefulness in treatment of various diseases. The healing of sick persons was carried out by priest doctors who prescribed and prepared medicaments. The first recorded prescriptions were found in ancient Egyptian tombs. The writing on the temple walls and in the papyri revealed that ancient Egyptians used many herbal drugs for the same purposes as they are used today. They used drugs of animal, plant, as well as mineral origins. From the first group, they used blood, meat, horn, milk, egg, honey and excreta. Among drugs of vegetable origin they used sycamore figs (*Ficus sycomorus* L.), lettuce (*Lactuca sativa* L.), lotus flowers (*Nymphaea lotus* L.), pomegranates (*Punica granatum* L.) and papyrus (*Cyperus papyrus* L.). They used all plant organs such as roots, rhizomes, flowers, leaves, fruits, seeds, as well as oils. They applied their medicaments in the form of powders, pills, suppositories, creams, pastes and ointments (Dagmar, 2006; Shahat *et al.*, 2001).

Although, several scholars have described the plant life in Egypt over the years, one of the first comprehensive reports for the flora of Egypt is that by Tackholm (1974). This was revised and updated in the four volumes recently published by Boulos (1999, 2000, 2002, 2005). This shows use of medicinal plants was and still is, widespread among the Egyptians for the treatment of several ailments. This has led to a buildup of wealth in the field of folklore medicine and scientists have attempted over the years to record and study the old recipes (Hamed *et al.*, 2007; Mahmoud *et al.*, 2007; Abdel-Azim, 1998). Furthermore, there is an increasing trend towards the use of natural remedies and hence the role of naturally occurring compounds and herbal teas are proving to be of increasing interest in the field of alternative medicine. Many plants are still used today in folklore medicine and are sold at herbal venders and shops all over Egypt. A few examples of some plants common to Egypt and their uses in ailment treatments are: *Acacia nilotica* (L.) Willd. ex Delile, *Achillea fragrantissima* (Forssk.) Sch.Bip., *Ambrosia maritima* L., *Citrullus colocynthis* (L.) Schradert, *Cleome amblyocarpa* Barr. and Murb., *Cleome droserifolia* (Forssk.) Delile, *Seriphidium herba-album* (Syn. *Artemisia herba alba*), *Solenostemma arghel* (Delile) Hayne. (Hammouda *et al.*, 2005). Only a few naturally occurring active compounds from plants have been developed by the pharmaceutical industry into products presently found on the market (Saleh, 2003). The following active principles have been isolated and are prescribed for the following treatments:

- Ammoidin and khellin (from *Ammi visnaga*). For the treatment of vitiligo and psoriasis
- Nigella seed oil (from *Nigella sativa* seeds). Pulmonary and general improvement of immune system
- Proximol (from *Cymbopogon proximus*). Propulsive for ureteric stones and urinary antiseptic
- Senna extract (from *Senna alexandrina* pods). Laxative

Table 1 shows the plants used for medicinal purposes in Egypt

ECONOMIC VALUE OF MEDICINAL PLANTS IN EGYPT

Nowadays, there is an increasing trend towards the use of herbal medicine in Egypt that reflects an increasing confidence in such remedies. Recently, the production of herbal drugs and herbal drug-based medicaments is a growing industry in Egypt. In addition, certain extracts and/or herbal drug constituents are produced together with what is called modern or western medicine in some pharmaceutical companies (Fabricant and Farnsworth, 2001). About 300 drugs, mainly imported, can be found in Egyptian market today. Besides, Egypt has one of the largest biodiversity and is a country with agricultural traditions. The flora of Egypt includes about 2000 species of plants distributed in its different localities that vary in type of soil and prevailing climatic and other environmental conditions that hence encourage the growth of a wide range of plant species. In addition, many plants have been successfully introduced and acclimatized in Egypt (Shams *et al.*, 2009). Egypt is characterized by abundant production of medicinal and aromatic plants that are exported all over the world and is considered as one of the most important sectors can be relied upon to increase the volume of Egyptian exports due to the growing global demand. Of the African countries, Egypt is by far the largest exporter in terms of both volume and value. Egypt's 2008 exports of selected botanicals amounted to 77,850,312 kg with a reported value of USD \$174,227,384.

Table 1: List of plants mentioned to be used for medicinal purposes in Egypt

Latin name of plant	Arabic name
<i>Cleome droserifolia</i> (Forssk.) Delile	Samoa
<i>Hyoscyamus muticus</i> L.	Sakaran
<i>Solenostemma arghel</i> (Del.) Hayne	Hargal El-Bahary
<i>Jasonia Montana</i> (Vahl) Botsch.	Heneda
<i>Teucrium polium</i> L.	Geida
<i>Artemisia judica</i> L.	Boeithran
<i>Salvia acetabulosa</i> L.	Mardakosh
<i>Mentha longifolia</i> L.	Habaq
<i>Origanum syriacum</i> L.	Zaatar
<i>Thymus decussates</i> Benth.	Zoeitran
<i>Zilla spinosa</i> Turra	Sella
<i>Achillea fragrantissima</i> (Forssk.) Del.	Kaysoom
<i>Citrullus colocynthis</i> L. Schrader	Hanzal
<i>Peganum harmala</i> L.	Harmal
<i>Hamada elegans</i> Bunge	Remth
<i>Anabasis articulate</i> Forssk	Agram
<i>Capparis cartilaginea</i> Deene.	Lasaf
<i>Retama raetam</i> (Forssk.)	Retam
<i>Artemisia herba- alba</i> Asso.(<i>Artemisia inculta</i> Del.)	Sheeh
<i>Globularia arabica</i> Jaub	Handaqq
<i>Rhus tripartite</i> (Ucria) Grande	Al-Erna
<i>Tamarix romaria</i>	Tarfa
<i>Moringa peregrina</i> (Forssk)	Liban
<i>Atraphaxis spinosa</i> L.	Serr
<i>Cassia senna</i> Simma L.	Sennameki
<i>Fagonia mollis</i> Del.	Shakaa
<i>Tanacetum santolinooides</i> DC.	Merr
<i>Capparis spinosa</i> L.	Lasof
<i>Ballota undulate</i> Sieb. Ex.	Gassa
<i>Stachys aegyptiaca</i>	Kortom
<i>Pistacia atlantica</i>	Albotom
<i>Ochradinus baccatus</i> Del.	Qerdhi

Egypt's exports of medicinal plants that are classified under generic HS Code 1211 represented 53.4% of the total volume and 33.6% of the total reported value.

Value added herbal extracts represented another 33% of the total value of Egyptian exports. The top five destinations for Egyptian medicinal plants in terms of reported value were USA (26.2% of total), Germany (24.9%), Poland (4.3%), Netherlands (3.9%) and Russian Federation (3.7%). The top five destinations for Egyptian herbal extracts and saps in terms of reported value were Saudi Arabia (29.4%), United Arab Emirates (7.8%), Syria (7.1%), Yemen (6.3%) and Algeria (5.8%) (Brinckmann, 2009).

CHALLENGES FOR MEDICINAL PLANTS IN EGYPT

While the trend of global trade in medicinal plants shows an increase in growth, the developing countries including Egypt are not able to take advantage of it. In these countries, several factors pose constraints to their entry into the international market and put them in a disadvantageous position (Samal *et al.*, 2004). In Egypt, there is a lack of:

- **Scientific evidence of the efficacy of traditional medicines:** The traditional system of medicines, though well documented and used safely for centuries, have no proven scientific basis of their efficacy. Egypt lacks essential infrastructure to carry out scientific testing. This makes the entry into the international market difficult
- **Uniform quality standards:** The uniformity of the collected material is often not possible owing to their different places of origin. This reflects in the inconsistent quality of the pharmacologically active secondary metabolites that is not desirable
- **Information:** The full potential of the traditional systems of medicine and the plants used in them are not economically exploited in the international market due to the need of information regarding their availability, on one hand. On the other hand, the local people do not have the necessary information about the requirements of the international market. They are also unaware of, or do not have access to, the technologies to upgrade their produce. This restrains them from venturing out into international trade
- **Intellectual Property Rights (IPR):** Plants have been used in traditional medicines for centuries and cannot be protected by patent. There is a need of an extensive documentation in Egypt that would facilitate information about the traditional uses of the medicinal plants to protect them from exploitation and bio piracy
- **Sustainable cultivation and processing technologies:** Egypt has been slow to realize the economic potential of its medicinal plant resources and has lagged behind in developing and implementing sustainable cultivation practices of medicinal plants. There is also the need of developing processing technologies. Currently there is a lack of cost-effective post harvest technologies like storage of raw materials and standardization, processing, packaging and storage of processed materials
- **Value addition:** The harvested materials are usually supplied in unprocessed form to the dealers. However, if the materials are processed into a more consumer useable form, the value added product would fetch a higher income as compared to the raw material. There is an urgent need of value addition at the source of collection/production.
- **Marketing strategies:** The raw materials reach the international market through a chain of dealers with little benefits to the local people. The promotion of the medicinal plant products is also lacking. Strengthening of the marketing strategies is required to make the trade more organized so that the grassroots level people have an equitable share in the profits (Green *et al.*, 1999)

UNIQUE FEATURES FOR EGYPT

Some features that make Egypt an ideal place for the growth of medicinal plants industry are:

- The geographical position of Egypt has made Egypt a hub of world trade since ancient times. Egypt can be a focal point in the field of medicinal plants in the Mediterranean and Arab region
- Big areas of newly reclaimed lands are available which should be used for cultivation of medicinal plants as these lands still virgin and free of contaminants and pollution. This will ensure the high quality required for the products
- Egypt with its wide variety of climatic and soil conditions has ample scope in gaining foothold in the global plant based pharmaceutical market
- Egypt has the largest community of qualified scientists in the region. This will facilitate the introducing the new technologies for processing and extraction on both laboratory and pilot scales. Scientists can help and transfer their experience to the private sector to modernize the traditional techniques already used in medicinal plants industry

- Egypt has already established a reputation as a low-cost manufacturer of many other industries in the global market. This fact can be used as an important tool for manufacturing and marketing of herbal products produced in Egypt

CRITICAL EGYPTIAN NEEDS

Knowledge is the key catalyst in enabling Egypt to become a global herbal producer. Currently, there is a lack of knowledge in three major areas: agricultural practice, pharmacology and process technology. There is also a need to train more knowledge workers in the relevant fields. More open knowledge on agricultural practice with respect to optimizing phytochemical content is needed in order to build the foundation of a herbal industry. Information on the best method of cultivation, duration of cultivation, on phytochemical rich parts of the plant material, are not well known for most Egyptian herbs. In addition, as herbal products are used for health and nutrition purposes, cultivation must be done with Good Agricultural Practice (GAP) as well as organic farming methods to ensure safety. A possible solution is to upgrade the current level of farming to a large scale contract farming with professional farm management, perhaps with the allocation of larger tracts of land from the state governments. The formation of a centre dedicated to studying the cultivation of herbs would also be an answer to this situation. The critical knowledge needed to build a herbal industry based on Egyptian medicinal plants is also dependant on more research done in pharmacology and clinical testing of local herbs. There is also a lack of knowledge in terms of active ingredients, synergy effects, critical dosages, side effects, contraindications with other herbs and medicines, animal and human tests. Without the establishment of this knowledge base, herbal medicines from Egypt cannot be sold internationally. Apart from agricultural and pharmacological knowledge, process knowledge also needs to be addressed. Phytochemical processing is a relatively new field in which chemical engineers and food technologists have been involved only recently.

As standardization is an important aspect of increasing value of phytomedicines, processing technology innovation is required for local herbs. Important areas needed in research include the development of environmentally friendly processes, the application of new and novel processing methods to local herbs and the enhancement of existing process technology. In addition, as the overall phytochemical yield of herbal extracts are between two to five percent, it is important to develop expertise in optimizing the process as process profitability can be increased through reduction of utilities usage, increase in phytochemical yield, reduction of extraction solvents and reduction of processing time.

More researchers are needed to accelerate the rate of growth of the industry. The important areas of research include ethnobotany studies, new plant and drug discovery, phytochemical studies, biological and clinical studies and drug testing.

A growing herbal industry will also need well-trained knowledgeable workers in terms of industrial workers including Natural Product Chemists and Phytochemical Processing Engineers.

DEVELOPMENT OF INNOVATIVE GREEN TECHNOLOGY

Extraction forms the first basic step in medicinal plant research because the preparation of crude extracts from plants is the starting point for the isolation and purification of chemical constituents present in plants. Yet the extraction step remains often a neglected area, which over the years has received much less attention and research. The traditional techniques of solvent extraction of plant materials are mostly based on the correct choice of solvents and the use of heat and/or agitation to increase the solubility of the desired compounds and improve the mass transfer.

Usually the traditional technique requires longer extraction time thus running a severe risk of thermal degradation for most of the phyto-constituents. The fact that one single plant can contain several secondary metabolites makes the need for the development of high performance and rapid extraction methods an absolute necessity (Wang and Curtis, 2006). Keeping in pace with such requirements, recent times has witnessed the use and growth of new extraction techniques with shortened extraction time, reduced solvent consumption, increased pollution prevention concern and with special care for thermo labile constituents. So, the motivation for the development of innovative green technology as viable separation techniques is a result of:

- A sharp increase in the cost of energy, which has increased the cost of traditional, energy-intensive separation techniques, such as distillation
- Increased governmental scrutiny and regulation of common industrial solvents, such as chlorinated hydrocarbons, which has made nontoxic, environmentally acceptable supercritical fluid solvents such as CO₂ very attractive as alternative industrial solvents
- More stringent pollution-control legislation, which has caused industry to consider alternative means of waste treatment
- Increased performance demands on materials, which traditional processing techniques cannot meet

Novel extraction methods including Microwave Assisted Extraction (MAE), supercritical fluid extraction (SCFE), Accelerated Solvent Extraction (ASE) and ultrasound extraction (USE) have drawn significant research attention in the last decade. If these techniques are explored scientifically, they can provide an efficient extraction technology for ensuring the quality of herbal medicines worldwide (Chemat *et al.*, 2004; Huie, 2002; Sueli and Gustavo, 2007; Letellier and Budzinski, 1999; Ayala and Luque de Castro, 2001; Latha, 2007).

Accordingly, Egypt needs an integrated approach to promote and develop the sector of medicinal plants right from the stage of cultivation, collection, storage, processing, packaging to marketing in an organized manner for selected medicinal plant species.

RECOMMENDATIONS FOR DEVELOPING MEDICINAL PLANTS SECTOR

The present worldwide interest in plant-based medicines needs to be harnessed by reframing a clear policy for the promotion of commercial cultivation, research and development and for the increase in exports of medicinal plants. For the development of the medicinal plant sector, there is a need to develop the coordinated efforts at each stage (e.g., research, cultivation, collection, storage, processing, manufacturing and marketing), which would be supported by an appropriate policy framework.

The future of Egyptian medicinal plants and herbal industry depends on how it prepares itself to face the challenges of the present such as regulatory concerns, consumer perceptions and competitions.

Medicinal plants and natural herb production and export from Egypt have been a major business and important source of income for many years. Among others; chamomile, fennel, anise, basil, peppermint and many other essential oils and fragrance crops that are cultivated in Egypt have a very good reputation in the international markets. However, recently exports of these products from Egypt to other countries are becoming more and more restricted due to the presence of unacceptable levels of contaminants and occasionally the occurrences of heavy metals, pesticides as well as some organic solvent residues.

Even authenticated plant material may not be of desired quality and strength and not conforming to the physicochemical parameters or the concentration of the active constituents or marker compounds as per the pharmacopoeia standards or the consumer/industry requirements. Such material is liable to be rejected or accepted at very low price causing not only economic loss but also entails doubtful efficacy or the potency of the raw drug in the alleviation of the human suffering.

Besides, the promotional efforts by the industries and government have not been sufficient to achieve the required potential presented by the markets abroad. Thus an appropriate planning and action based on the market requirements is essential.

REFERENCES

- Abdel-Azim, N.S., 1998. A cardnolide glycoside from *Gomphocarpus sinaicus*. *Phytochemistry*, 49: 273-275.
- Ayala, R.S. and M.D. Luque de Castro, 2001. Continuous subcritical water extraction as a useful tool for isolation of edible essential oils. *Food Chem.*, 75: 109-113.
- Boulos, L., 1999. *Flora of Egypt*. Vol. 1, Al-Hadara Publishing, Cairo, Egypt.
- Boulos, L., 2000. *Flora of Egypt*. Vol. 2, Al-Hadara Publication, Cairo, Egypt.
- Boulos, L., 2002. *Flora of Egypt*. Vol. 3, Al-Hadara Publication, Cairo, Egypt, ISBN: 977-5429-25-0.
- Boulos, L., 2005. *Flora of Egypt*. Vol. 4, Al-Hadara Publication, Cairo, Egypt.
- Brinckmann, J., 2009. *Medicinal Plants and Extracts*. International Trade Center, Geneva, Switzerland.
- Chemat, S., A. Lagha, H. Aitamar, P.V. Bartels and F. Chemat, 2004. Comparison of conventional and ultrasound-assisted extraction of carvone and limonene from caraway seeds. *Flavours Fragrance J.*, 19: 188-195.
- Dagmar, L., 2006. *International Trade in Medicinal and Aromatic Plants, Actors, Volumes and Commodities, Plants*. In: *Medicinal and Aromatic Plants*, Bogers, R.J., L.E. Craker and D. Lange (Eds.). Springer, USA, pp: 155.
- Fabricant, D.S. and N.R. Farnsworth, 2001. The value of plants used in traditional medicine for drug discovery. *Environ. Health Perspect.*, 109: 69-75.
- Green, E.C., K.J. Goodman and M. Hare, 1999. Ethnobotany, IPR and benefit sharing: The forest people fund in Suriname. *Indigen. Knowledge Dev. Monit.*, 7: 8-11.
- Hamed, A.R., K.A. Abdel-Shafeek, N.S. Abdel-Azim, S.I. Ismail and F.M. Hammouda, 2007. Chemical investigation of some *Capparis* species growing in Egypt and their antioxidant activity. *EBCAM.*, 4: 25-28.
- Hammouda, F.M., S.I. Ismail, N.S. Abdel-Azim, K.A. Shams and K.H. Batanouny, 2005. IN a Guide to Medicinal Plants in North Africa. IUCN Centre for Mediterranean Cooperation, Malaga, Spain.
- Harbir, S., 2006. Prospects and challenges for harnessing opportunities in medicinal plants sector in India. *Law Environ. Dev. J.*, 2: 198-211.
- Huie, C.W., 2002. A review of modern sample-preparation techniques for the extraction and analysis of medicinal plants. *Anal. Bioanal. Chem.*, 373: 23-30.
- Latha, C., 2007. Microwave-assisted extraction of embelin from *Embelia ribes*. *Biotechnol. Lett.*, 29: 319-322.
- Letellier, M. and H. Budzinski, 1999. Influence of sediment grain size on the efficiency of focused microwave extraction of polycyclic aromatic hydrocarbons. *Analyst*, 124: 5-14.

- Mahmoud, S.M., N.S. Abdel-Azim, A.A. Shahat, S.I. Ismail and F.M. Hammouda, 2007. Phytochemical and biological studies on *Verboscum sinaiticum* Benth. Growing in Egypt. Nat. Prod. Sci., 12: 186-189.
- Saleh, N.A., 2003. Global phytochemistry: The Egyptian experience. Phytochemistry, 63: 239-241.
- Samal, P.K., A. Shah, S.C. Tiwari and D.K. Agrawal, 2004. Indigenous health care practices and their linkages with bio-resource conservation and socio-economic development in central Himalayan region of India. Ind. J. Tradit. Knowledge, 3: 12-26.
- Shahat, A.A., L. Pieters S. Apers, N.M. Nazeif, N.S. Abdel-Azim, D.V. Berghe and A.J. Vlietinck, 2001. Chemical and biological investigations on *Zizyphus spina-christi* L. Phytother. Res., 15: 593-597.
- Shams, K.A., N.M. Nazif, N.S. Abdel-Azim, K.A. Abdel-Shafeek, M.M. El-Missiry, S.I. Ismail and M.M.S. El-Nas, 2009. Isolation and characterization of antineoplastic alkaloids from *Catharanthus roseus* L. Don. cultivated in Egypt. Afr. J. Tradit. Complement Altern. Med., 6: 118-122.
- Sueli, R. and A.S.P. Gustavo, 2007. Ultrasound extraction of phenolic compounds from coconut (*Cocos nucifera*) shell powder. J. Food Eng., 80: 869-872.
- Tackholm, V., 1974. Student's Flora of Egypt. Cairo University Press, Cairo, Egypt.
- UNESCO, 1996. Culture and health, orientation texts-world decade for cultural development 1998-1997. Document CLT/DEC/PRO-1996, Paris, France, pp: 129.
- UNESCO, 1998. FIT/504-RAF-48 terminal report: Promotion of ethnobotany and the sustainable use of plant resources in Africa. Paris, pp: 60.
- Wang, L. and L. Curtis, 2006. Recent advances in extraction of nutraceuticals from plants. Trends Food Sci. Technol., 17: 300-312.