Image courtesy of the CSIR

Case Study: Hoodia

Species of Hoodia, a succulent plant indigenous to Southern Africa have been used for over a century by the San people as an appetite suppressant. Developed by South African scientists at the Council for Scientific and Industrial Research (CSIR), based on the San's traditional knowledge, this home grown example of bioprospecting is the first natural food ingredient for weight management based on a plant indigenous to the African continent. An agreement reached between the CSIR and the San, an indigenous people of Southern Africa, was one of the first globally where the holders of traditional knowledge received a share of royalties/financial benefits from the patenting of the active constituents. This agreement came about following international media pressure that revealed that the San had not been consulted or included in the patent application.

Research began at the CSIR in 1963 when the properties of some Hoodia species were first validated under scientific conditions, and today includes major multi-national companies, farmers and communities and has been patented in most countries of the world. Unilever, the main company developing Hoodia, recently announced its withdrawal from Hoodia, indicating some of the challenges of natural product development. Numerous other industry players are however still involved in trading Hoodia as a food supplement, leading to potential benefits for the San.

Despite the challenges and complexities of the Hoodia example, it demonstrates the potential of bioprospecting to produce significant economic and social benefits for a nation and a region based on its biodiversity and indigenous knowledge. It has also set an international precedent for how holders of traditional knowledge should be compensated for their knowledge.

Key issues & challenges

- **Conservation versus exploitation:**
  Conservation is not always the top priority of nations, and some seek to make a quick profit from their natural resources rather than preserving them. As a result, the biodiversity they wish to exploit is disappearing. Bioprospecting profits could be used to finance biodiversity conservation in species rich developing countries and non-financial benefits could be shared through technology and knowledge transfer to enable these nations to research and conserve their own biodiversity.

- **Suspicion and mistrust:**
  Providers and users of genetic diversity are increasingly estranged. As biodiversity rich developing nations learn to assert their sovereignty rights under the CBD, they may become oversensitive to bioprospectors based on memories of colonial times when Africa was used as a free source of plants. This occurs even when research is not for commercial gain, and the reputation of all is tainted by those that have committed biopiracy.

- **Lack of legal clarity:**
  There is a need for clearer, more specific rules on how origins of samples and IK are recorded and their benefits shared, both nationally and abroad. Should the commercial benefit accrue to those who discovered the active ingredient or the biotech company able to identify/improve on this key ingredient? These issues have to be resolved in South Africa for companies to be willing and able to use our resources.

- **Greater sector involvement:**
  Many sectors actively involved in bioprospecting remain ignorant of the regulations, and are committing biopiracy. Education and participation in relevant international and national discussions is needed to ensure regulation across all sectors.

The PUB programme is an initiative of the Department of Science and Technology and is implemented by SAASTA.
The mandate of PUB is to promote a clear, balanced understanding of the potential of biotechnology and to ensure broad public awareness, dialogue and debate about biotechnology and its current and potential applications.
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PROMOTING A CLEAR, BALANCED UNDERSTANDING OF BIOTECHNOLOGY

PUBLIC UNDERSTANDING OF BIOTECHNOLOGY

BIOPROSPECTING: PUTTING NATURE TO WORK

What is bioprospecting?

Bioprospecting, also known as biodiversity prospecting, is the exploration of biological material for commercially valuable genetic and biochemical properties. In simple terms this means the investigation of living things to see how they can be commercially useful to humans. Small samples of natural resources are collected for their potential value to industry, particularly in the pharmaceutical, biotechnology and agri-business fields. Local communities close to where the material originates may have specialised knowledge on how the resources are used, which can also be collected, and this is known as traditional or indigenous knowledge (IK).

Biological diversity (biodiversity) refers to all living things, including plants, animals, insects and marine life. New technologies are also now enabling microbes to be investigated. However, not all investigations on biodiversity are considered bioprospecting: academic or conservation research is excluded from the term. Nor does it include commercial use of natural resources e.g. medicinal plants as trade commodities.

However, gone are the days when scientists could "bring home suitcases of leaves, mushrooms or whatever which would often be sold for cash". When biodiversity or related knowledge is collected without permission from the owners of these resources and then patented, it is known as biopiracy.

Why is it needed?

The underlying aim of bioprospecting is to find new resources and products from nature that can be used by humans. Improving human health, through both medicine and better nutrition are key focal areas. Bioprospecting plays a dominant role in discovering leads for drug development, since existing/known compounds for developing drugs for human use are limited. Nature can provide original novelty and complexity that can be modified in the laboratory.

A study showed that between 1983 and 2003, almost two thirds of anti-cancer agents being investigated as drug candidates were derived from natural products. Between 1981 and 2006, 47% of cancer drugs and 34% of all small molecule new chemical entities for all disease categories were either natural products or directly derived thereof.

Other related sectors, such as crop plant biotechnology, screen natural resources for useful traits, such as disease resistance, but tend to focus more on modern varieties of crops with an emphasis on improving performance and farming efficiency.

Where is it happening?

Although bioprospecting can happen wherever there is biodiversity, it tends to be focused where biodiversity is at its richest, as this raises the chances of finding something useful.

NRF National Research Foundation | SAASTA South African Agency for Science and Technology Advancement

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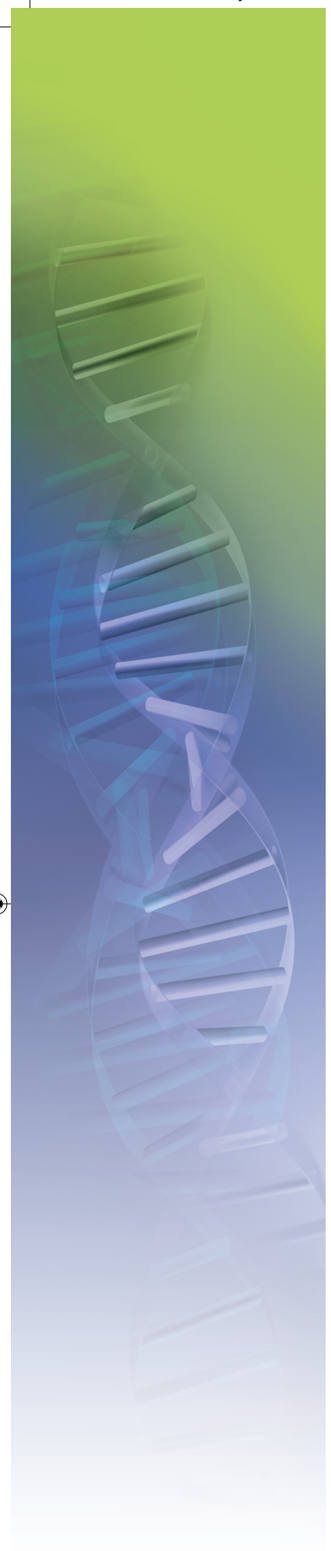

Statistically, the chance of a successful "hit" is one in 10,000 for synthetic compounds and one in 30,000 or 40,000 for natural products. Extreme environments and unique ecological niches are also good sources for diversity, such as Antarctica. Yet, only a tiny fraction of the world's biodiversity has actually been explored and the richest areas of biodiversity tend to be in developing countries. Legal uncertainties are also causing companies to opt out from bioprospecting in some countries.

How is it done?

Bioprospecting can be divided into three phases: collecting, analysis and commercialisation. Samples and/or indigenous knowledge related to a sample are collected, and then undergo analysis – using a variety of different technologies. In the early days, analysis was very time consuming and costly, but in the late 1980's techniques were significantly improved, making the screening of natural product molecules simpler, faster and easier – a factor which affects both the impact and level of bioprospecting. For example, novel and naturally occurring antibiotics are still being discovered from natural products libraries that are decades old. These advances ultimately mean that the demand for new natural collections will decline – as existing collections and local biodiversity are studied more comprehensively.

Once a "hit" has been identified, it can take 20 years (depending on how the material is used) before the final product completes clinical trials and can be commercialised. For example it can take 12-15 years and upward of US$800 million indirect and non-direct costs to bring a drug to the US market. Only 20% of drugs that begin clinical testing proceed to trial and eventually for marketing approval - and only three out of 10 drugs that are finally marketed recoup their development costs. It is a long and costly process which may result in little or no benefits.

Who does bioprospecting?

Bioprospecting cuts across a range of different sectors, including the pharmaceutical, agri-business (biotechnology, seed, crop protection and horticulture), cosmetic and personal care, fragrance, botanicals, and the food and beverage industries. However: the degree and way in which these sectors access and use these resources vary significantly. The pharmaceutical and agri-business sectors are more involved, whereas, according to Laird and Wynberg (2008) the cosmetic, fragrance, botanicals and food and beverage industries still "do" bioprospecting, but are not always aware of, or compliant to, the regulation and legislation and may commit biopiracy by commercialising natural resources.

In the past 15-20 years large pharmaceutical companies have scaled back their bioprospecting activities and closed their natural products programmes. This is due to the "slim pickings" and extensive financial outlay required, combined with complex negotiations over intellectual property (IP). Natural products research is very resource intensive – requiring lots of money, people and expertise, making large companies reluctant to get involved again significantly. Instead, smaller, focused companies are becoming productive – obtaining leads and "hits" and then working with the larger companies to develop the products.

Today, the majority of natural products research is undertaken in academic and government research institutes or in smaller discovery companies.

Regulation of bioprospecting

The politics of bioprospecting are highly complex and continue to hinder natural product development. The most significant change and the starting point of international regulation and legislation took place at the Rio Earth Summit in 1992, when participating countries discussed bioprospecting and signed the Convention of Biological Diversity (CBD). The CBD recognises the need for conservation, sustainable use and equitable benefit sharing as cornerstones, and for the first time, acknowledged the sovereign rights of countries over their natural resources. It meant that biodiversity could no longer be regarded as common property and that the origin of the material used was recognised.

In 2003, international negotiations began for a legally binding international regime on access and benefit sharing (ABS) in relation to biological resources and traditional knowledge and are due to be concluded in 2010. In the meantime, almost 60 countries, including South Africa have or are in the process of adopting ABS measures.

In South Africa, a number of national policy documents relevant to bioprospecting have emerged over the years since the CBD, but only recently has bioprospecting specific legislation come into play in the form of the National Environmental Management: Biodiversity Act, 10 of 2004 (the Biodiversity Act). Prior to this, developing biological diversity commercially involved bilateral agreements between those desiring access to genetic resources (typically a foreign company/research institute and those providing access (typically a local research institute).

Regulations relating to bioprospecting (Chapters 6 and 7 of the Biodiversity Act) came into force on 1 April 2008 - providing a more relevant legal framework for bioprospecting activities. The regulations require users of biodiversity to first obtain permission to commercialise local biodiversity or related knowledge. They must also ensure that they share benefits fairly with holders of knowledge and those providing the biological resources. If applications are in order, bioprospecting and export permits are issued by the Minister of Environmental Affairs and Tourism (DEAT), since the Act is enforced and implemented by DEAT. The Act provides for a Biodiversity Trust Fund where all financial benefits will be deposited for redistribution to communities. Although the regulations are a significant step forward in the ACS of bioprospecting, there are a number of problems with this relatively new legislation, including:

- Limitations on ensuring the benefits of bioprospecting go to the wider community i.e. and not a landowner or research institute only;
- Capacity development (training and education) for those involved in implementing the CBD and ABS regulations (i.e. government) and in the wider communities and interest groups affected by the regulations. The lack of know-how and specifics of the system are currently causing companies to opt out from using traditional knowledge;
- The establishment of a Task Team has been proposed to advise DEAT on ABS regulations and the development of SA positions on the negotiations of an international regime on ABS;
- Greater attention to how beneficiaries are identified, especially indigenous communities – including the development of clear, concrete principles and tools for all the parties involved in biosprospecting;
- Regular review of the regulations and remaining up to date on related issues.

Related legislation, South Africa's Patent Act, 57 of 1978, has also been amended to reflect the commitment of South Africa to disclose the origin of genetic material and traditional knowledge by current patent holders.

What is happening in South Africa?

South Africa is recognised as the third richest centre of biodiversity in the world, having well over 20,000 indigenous plant species, apart from animal, marine and microbial diversity. South African scientists first began looking at the properties of local plants due to farm livestock losses caused by grazing on toxic plants, and at indigenous plants eaten by rural communities. This well developed research capacity, combined with the rich biodiversity and traditional knowledge, makes South Africa a prime location for bioprospecting.

A 1996 review of bioprospecting activities in South Africa showed almost all research institutes in South Africa to be involved in bioprospecting in one form or another.

During the period between 1 April and 31 December 2008 following the enforcement of the bioprospecting regulations in South Africa, a total of 34 permit applications were received from 12 organisations. This included both new and all existing bioprospecting projects countrywide. Of the 34 applications, 1% cited international collaborators, with the majority of applications coming from South African based companies. Details on the research being undertaken remain confidential until the projects are at a relevant stage to be made public and as yet, no permits have been authorised (TBC).

Probably the best known recent examples is the development by the Council for Scientific and Industrial Research (CSIR) and the UK-based company Phytopharm of an anti-obesity drug, based on the San people's traditional knowledge of a Kalahari plant called Hoodia (see box).

Other home grown examples of bioprospecting include the development of South African plants for ornamental horticulture products by the US-based company, Ball Horticulture and more recently, the identification of a potential new antibiotic from SA soil samples by the pharmaceutical company Merck.

Indigenous Knowledge

Traditional or indigenous knowledge (IK) is local knowledge that is unique to a culture or society. It is passed down generations, usually by word of mouth and cultural rituals, and has been the basis for agriculture, food preparation, health care, education, conservation and the wide range of other activities that sustain societies in many parts of the world. The use of IK is even more complex than that of genetic resources and ABS related to IK remains very unclear as no one case is the same.

As a result of these complexities, many companies simply avoid using IK altogether and instead obtain material from international or national genebanks where the process is often clearer. When IK is pursued in a country relating to a specific resource, companies tend to use local intermediaries to liaise with local communities as they are considered "better equipped to do so".