

WETLANDS AND SOCIETY

Protecting nature's medicine cabinet: How research is upping the value of endangered aquatic ecosystems

The bulk of South Africans, about 70%, look to traditional medicine for their primary healthcare. An estimated 19 500 tons of medicinal plants are harvested to treat various illnesses each year. Most of these are terrestrial but the healing, and the market value of South Africa's wetland plants have now been proven scientifically too. Article by Petro Kotzé



With support from Water Research Commission (WRC) funding, three indigenous aquatic plants are close to commercialisation and will be available on the market to treat skin disorders that include acne, hyperpigmentation, and wrinkles. It's the latest step in decades-long attempts by the WRC to prove the value of wetlands, and to promote their conservation.

One of the mechanisms to protect nature is to demonstrate how it benefits people, says Bonani Madikizela, WRC Research Manager. Rather than top-down mechanisms like fences, laws, policing and punishment this approach works from the bottom up, by motivating people themselves to protect a resource of value to them. "Plants worth money, are worth protecting," he explains.

Promoting research that allows for this value to be taken all

the way to the shop shelves also creates numerous other opportunities along the way, many of which are more appealing to a youth that is not interested in dirtying their hands on ground level. Still, he cautions, it has to be clear where this value comes from, in order to sustain the future of the aquatic ecosystem and the business opportunities gained from it.

It's a social-ecological systems approach, Madikizela notes. This broadly refers to an approach that includes biological, social, and economic subsystems. Funding for research in this direction had already started when he arrived at the WRC 15 years ago, he says, but it has developed in leaps and bounds since.

The research behind the research

Early work was driven by a handful of eminent ecologists, who

increasingly understood nature as complex systems, that cannot be managed or conserved in silos, or fenced off from societies. First, the building blocks had to be laid, and initial work focused on the identification and taxonomy of wetland vegetation. "Some of the plants have been used by our local people for donkey's years, but they've never seen any kind of publicity or generated income or revenue," Madikizela says. "They have been marginalised."

An earlier WRC project focused on listing medicinal plants that occur in freshwater systems in South Africa (more than 200 were listed) and included current indigenous knowledge and the biodiversity that represents the plants utilised for medicinal purposes. An attempt was also made to identify plants that could be subjected to more detailed biotechnological research.

Aquatic plants can produce phytochemicals that protect them from environmental stresses. These phytochemicals have been used in drug development to treat human diseases for centuries, but minimal research has been undertaken to explore the potential of indigenous South African aquatic plants and their potential for the treatment of various diseases.

Then, eight years ago, Madikizela picked up a newspaper and noticed something that would propel the work forward on

local shores too. Prof Namrita Lall of the University of Pretoria's Department of Medicinal Plant Sciences had just been awarded the National Order Presidential Award (Order of Mapungubwe, Bronze) for her outstanding contribution to the field of medical science. The award highlighted her work on the extraction and identification of compounds from medicinal plants used to treat tuberculosis and other bacterial infections. She was exactly the researcher that Madikizela was looking for.

From the wetland to the laboratory

Lall's collaboration with the WRC led to the identification of twenty-seven indigenous aquatic plants, selected on their traditional use, sustainability, and the quantity of available material, for further investigation. Their potential for the treatment of skin orders, including acne, hyperpigmentation, wrinkles, dental infections, tuberculosis, and cancer was investigated.

Though none of the samples displayed significant anti-cancer activity, some did show very good promise for the promotion of even skin tone and the improvement of wrinkles. Three plant extracts also showed potential for the treatment of tuberculosis and others, traditionally used for treating toothache, showed potential that could be explored further in studies for oral care.

South Africa's disappearing wetlands

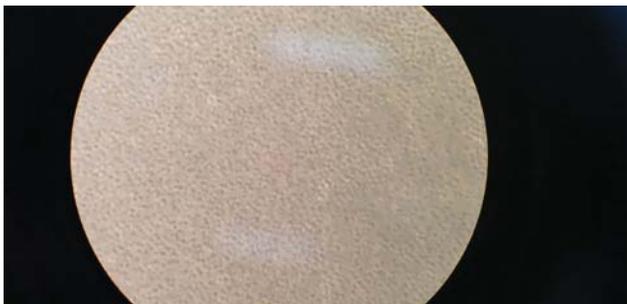
A wetland is defined in the National Water Act (Act 36 of 1998) as the land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

According to the National Biodiversity Assessment 2018, estuarine and inland wetland ecosystems face many pressures and are highly threatened. Of South Africa's 135 inland wetland ecosystem types, 79% are threatened, only 6% are well protected and 61% are not protected at all. Common threats listed are freshwater flow modification; overfishing and bait collection; pollution; habitat loss; climate change; and, biological invasions. Together with indigenous forests, lakes, estuaries, mangroves, dunes, beaches, rocky shores, kelp forests, reefs, seamounts, pinnacles and islands, inland wetlands take up less than 5% of South Africa's territory, but these small ecosystem types contribute disproportionately to a large number of benefits such as water purification, nutrient cycling, carbon storage, storm protection, recreation and food. Managing, protecting and restoring these small, high-value ecosystems will secure essential benefits and deliver large return on investment.



Compound isolation was done on one of the aquatic plant species. From this seven major fractions were pulled from the partition that showed the best activity (image of each fraction individually).

Marize Nel



Granulocytes are used to detect histamine.

Madikizela points out that such scientific endeavors are incredibly expensive, so the research team had to be very selective with the plants that they took forward. "We chose the ones that we were sure we could demonstrate to be viable and could commercialise successfully," he says. Three options were selected, all of which showed to be effective treatments.

Clinical studies confirmed that one plant was effective in promoting even skin tone after 14 to 28 days of consecutive use, twice a day. Clinical studies proved two more to be effective in reducing the appearance of wrinkles after 14 to 28 days of consecutive use, twice a day. Based on their outstanding biological activities, these plants were selected for further cultivation studies and are being grown at a farm in Limpopo Province that is involved in several community-based upliftment projects.

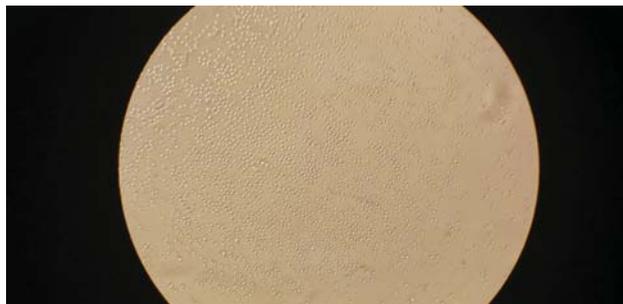
And, currently, all three plants are near commercialisation, says Lall. She also sees large potential for further studies. "There is limited information on the medicinal potential of wetland plants in comparison to terrestrial," she says. In her opinion, however, "by further investigating medicinal aquatic plants there is a potential to promote the development of South African products that are effective and have fewer side effects as well as to initiate the rehabilitation of lost wetland areas which will create job opportunities."

"Furthermore, as more information is discovered on these wetland plants it will promote the rehabilitation of wetlands since most of this land has been reclaimed for agricultural purposes or has been polluted with waste from surrounding areas."

With the groundwork now laid other researchers can continue working with the plant species already identified to have medicinal value. "That's what the research does," says Madikizela. "When you are done with one project, you already have hundreds more questions." Recommendations for future research include clinical studies for oral care for selected aquatic species and the potential for targeting antibiotic resistance associated with tuberculosis. Over and above that, three MSc and three PhD students have been funded by the WRC and are building their careers on the research topic.

Young researchers are taking the baton and running with it

One such post-graduate student is Marize Nel, who is busy completing her Master's degree in Medicinal Plant Sciences at the University of Pretoria's Department of Plant and Soil Sciences.



Peripheral blood mononuclear cells were used to detect tumour necrosis factor-alpha.

Nel says she realised the impact that herbal medicine can have when researched properly in her first year, and has dedicated her studies to the topic since. This soon developed into a focus on aquatic medicinal plants. "That interest came later in my life when I realised how under-researched these species were," she says.

"As more information is discovered on these wetland plants it will promote the rehabilitation of wetlands."

She is continuing work on the selected plants that possess hyperpigmentation properties and reduces the formation of wrinkles. These are known side effects of eczema, she says. In an attempt to reduce the severity of eczema other aspects were also analyzed such as whether they can reduce tumor necrosis factor-alpha production. This, Nel explains, is a pro-inflammatory cytokine involved in the formation of eczema and post-inflammatory hyperpigmentation. Her work also involves investigating whether one of the selected species can reduce histamine production, which causes an intolerable itching sensation that further increases wrinkle formation, she says.

She is, however, not nearly done. In the future, she would like

Preparing plant extracts

The plant materials collected from the areas surrounding the water are rinsed and frozen at minus 80°C for three days. Then, the materials are freeze-dried and ground to a fine powder. The ground plant material is weighed to allow for a 1:5 ratio of plant material to 100% ethanol. Species collected directly from the water are blended with ethanol in the same ratios after surface rinsing. Both mixtures are then placed on a shaker and left to shake for seven days. After this, the ethanolic extraction liquid is separated from the ground/blended plant material using a filter and vacuum pump. The ethanol is evaporated and the resulting extract kept in a minus 4°C freezer to be used for experiments.

Global contribution to research

Lall has since made tremendous contributions to the field of research that explores the medicinal value of aquatic plants. She edited the book, *Aquatic Plants: Pharmaceutical and Cosmetic Applications*, that was published in 2020. The book provides a concise description of popular aquatic plants found across the globe. Chapters focus on the aquatic species native to specific continents. Written by a global team of experts the publication explains the distribution, ethnobotanical uses, genome sequencing, chemical compounds, and biological activity of these plants and addresses the cultivation and sustainable production of aquatic and wetland plants. The publication is a valuable resource for academics conducting research on aquatic plants and for professionals in the pharmaceutical and cosmetic industries who are involved with the therapeutic applications of these plants and their sustainable usage.

to investigate how one of the selected species reduces the mentioned tumor necrosis factor-alpha, as well as its effect on the condition when applied topically. Furthermore, Nel says she would like to investigate other aspects of the condition (eczema) due to its spike in occurrence over the years both in children and adults, with an eye on finding out if these plants could potentially reduce those aspects.

Nel is clear on why she has chosen this route and is sticking to it. "Aquatic plants are under-rated and their potential use is being minimised due to the continuous loss of our wetland areas." The young researcher says more research should be done on these plants in order to promote the importance of protecting the area where they come from and to emphasize how valuable South African aquatic plants are due to their medicinal properties.

Beyond her studies, she can already see how she can potentially carve out a career for her in the field. She could potentially continue at the University of Pretoria as a lecturer in the field of Medicinal Plant Sciences, she says. "Not only will this provide me the opportunity to potentially develop an effective eczema treatment but I may be able to peak more students' interest in the medicinal value of plants and show them the importance of this field."

Ensuring that the benefits ripple back to ground-level

Until the commercialisation process has been finalised, the experts are keeping on mum on details of which specific aquatic plants are being developed. Madikizela says that the process



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Medicinal aquatic plants have the potential to promote the development of South African products that are effective and have fewer side effects says Prof Namrita Lall.



Supplied

Marize Nel is one of the next generation of young scientists that will take the field of research on the medicinal value of indigenous, aquatic plants forward in South Africa.

of registering the concomitant Intellectual Property is ongoing and until then, such details will be kept under wraps. Though the process is challenging, it can help ensure that benefits are filtered back to communities on the ground level since shareholding and beneficiation will be part of a negotiation process should a developer step in, to upscale the products. The hope is that one day in the not-too-distant future, savvy shoppers can contribute to the sustainable future of wetlands, by simply swiping for the right products selected from the shop shelves.

References:

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- Distribution, use and ecological roles of the medicinal plants confined to freshwater ecosystems in South Africa, by J Wentzel and CE van Ginkel, WRC Report No. KV 300/12