



Super vegetables

Long overlooked in parts of Africa, indigenous greens are now capturing attention for their nutritional and environmental benefits.

One lunchtime in early March, tables at Nairobi's K'Osewe restaurant are packed. The waiting staff run back and forth from the kitchen, bringing out steaming plates of deep-green African nightshade, vibrant amaranth stew and the sautéed leaves of cowpeas. The restaurant is known as the best place to come for a helping of Kenya's traditional leafy green vegetables, which are increasingly showing up on menus across the city.

Just a few years ago, many of those plates would have been filled with staples such as collard greens or kale — which were introduced to Africa from Europe a little over a century ago. In Nairobi, indigenous vegetables were once sold almost exclusively at hard-to-find specialized markets; and although these plants have been favoured by some rural populations in Africa, they were largely ignored by seed companies and researchers, so they lagged behind commercial crops in terms of

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productivity and sometimes quality.

Now, indigenous vegetables are in vogue. They fill shelves at large supermarkets even in Nairobi, and seed companies are breeding more of the traditional varieties every year. Kenyan farmers increased the area planted with such greens by 25% between 2011 and 2013. As people throughout East Africa have recognized the vegetables' benefits, demand for the crops has boomed.

This is welcome news for agricultural researchers and nutritional experts, who argue that indigenous vegetables have a host of desirable traits: many of them are richer in protein, vitamins, iron and other nutrients than popular non-native crops such as kale, and they are better able to endure droughts and pests. This makes the traditional varieties a potent weapon against dietary deficiencies. "In Africa,

malnutrition is such a problem. We want to see indigenous vegetables play a role," says Mary Abukutsa-Onyango, a horticultural researcher at Jomo Kenyatta University of Agriculture and Technology in Juja, Kenya, who is a major proponent of the crops.

Scientists in Africa and elsewhere are now ramping up studies of indigenous vegetables to tap their health benefits and improve them through breeding experiments. The hope is that such efforts can make traditional varieties even more popular with farmers and consumers. But that carries its own risk: as indigenous vegetables become more widespread, researchers seeking faster-growing crops may inadvertently breed out disease resistance or some of the other beneficial traits that made these plants so desirable in the first place.

"It is important

Women sell African nightshade and other green vegetables at a market in Nairobi.

that when we promote a specific crop, that we try to come up with different varieties,” says Andreas Ebert, gene-bank manager at the World Vegetable Center (AVRDC), an agricultural-research organization based in Shanhua, Taiwan. If the increasing popularity of these vegetables limits choices, he says, “the major benefits we are currently seeing will be lost”.

PROTEIN FROM PLANTS

For Abukutsa, indigenous vegetables bring back memories of her childhood. Cow’s milk, eggs and some fish made her ill, so doctors advised her to avoid all animal protein. Instead, the women in her family made tasty dishes out of the green vegetables that grew like weeds around her house. Her mother often cooked the teardrop-shaped leaves of African nightshade (*Solanum scabrum*), as well as dishes of slimy jute mallow (*Corchorus olitorius*) and the greens of cowpeas, known elsewhere as black-eyed peas (*Vigna unguiculata*). One grandmother always cooked pumpkin leaves (*Cucurbita moschata*) with peanut or sesame paste. Abukutsa relished them all and ate the greens with ugali, a polenta-like dish common in East Africa.

She chose to pursue a career in agriculture because she wanted to “unravel the potential hidden in African indigenous vegetables”, she says. Now, she is considered a leader across Africa, and increasingly around the world, in a robust, rapidly growing field. “She’s almost like the mother of indigenous vegetables in Kenya,” says Jane Ambuko, head of horticulture at the University of Nairobi.

Abukutsa started out in the early 1990s, surveying and collecting Kenya’s indigenous plants to investigate the viability of the seeds that farmers were using. In the decades since, she has come to focus mainly on the vegetables’ nutritional properties.

Today, she is far from alone. The AVRDC has a dedicated research and breeding programme at its office in Arusha, Tanzania, and the Kenya Agricultural and Livestock Research Organization in Nairobi does similar work. Other health and agriculture organizations in both East and West Africa focus on boosting consumer use and improving the viability and yield of these crops. That fits into a global trend emphasizing bioregional foods — using crops that are well adapted for a given climate and environment, rather than foreign plants that tend to be less nutritious and require extra water or fertilizers.

Most of the indigenous vegetables being studied in East Africa are leafy greens, almost all deep green in colour and often fairly bitter. Kenyans especially love African nightshade and amaranth leaves (*Amaranthus* sp.). Spider plant (*Cleome gynandra*), one of Abukutsa’s favourites for its sour taste, grows wild in East Africa as well as South Asia. Jute mallow has a texture that people love or hate. It turns slimy when cooked — much like okra. Ebert says

that moringa (*Moringa oleifera*) is not only one of the most healthful of the indigenous vegetables — both nutritionally and medicinally — but it is also common in many countries around the world.

Research by Abukutsa and others shows that amaranth greens, spider plant and African nightshade pack substantial amounts of protein and iron — in many cases, more than kale and cabbage¹. These vegetables are generally rich in calcium and folate as well as vitamins A, C and E (ref. 2).

Researchers risk eliminating the traits that make indigenous vegetables so desirable in the first place.

In recent years, Abukutsa has been studying how to maximize nutritional benefits using different cooking methods. Compared with raw vegetables, boiled and fried greens contain much more usable iron³ and could help to combat the high rates of anaemia in parts of East Africa. They can also be important sources of protein, she says. “Some people just live on vegetables, and they cannot maybe afford meat.”

Abukutsa is currently studying the antioxidant activity of indigenous vegetables, as well as how resilient they are to the effects of climate change. Most of the traditional varieties are ready for harvest much faster than non-native crops, so they could be promising options if the rainy seasons become more erratic — one of the predicted outcomes of global warming. Slenderleaf (*Crotolaria* sp.) is particularly hardy during drought because it quickly establishes its taproot. “If we have a short rain because of climate change, it can survive,” she says. She is working with other research partners to select vegetables with increased tolerance for variations in rainfall and temperature.

Early on, Abukutsa recognized that she needed to do more to convince people to add indigenous vegetables to their diets. Since around 2000, she has led public education campaigns and worked with restaurants and supermarkets around Kenya to find out what

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they would need to start selling these foods. A simple but significant problem was that people did not know how to cook the vegetables.

Unlike larger leafy vegetables such as kale, many of the indigenous varieties have small leaves that must be separated from their stems individually before cooking — a laborious process. Recipes are often vegetable-specific; spider plant can be cooked with sour milk, for example, but cowpea leaves go better with soya bean or peanut paste. Although older generations and some rural populations know what to do with nearly any local vegetable, much of the region’s traditional cooking knowledge has been lost. So Abukutsa got to work on collecting and testing recipes to maximize the amount of iron and other nutrients the dishes contain. K’Osewe was one of the first restaurants to take an active interest, and others soon followed.

For Abukutsa, indigenous vegetables are not just a research subject — they remain a central part of her own diet. “Today at lunchtime, I ate pumpkin leaves and nightshade,” she says.

The vegetables’ new-found popularity is spreading throughout East Africa. At a bustling market in Arusha, a young woman wearing a light-blue headscarf shops for sweet-potato leaves (*Ipomoea batatas*), known locally as matembele, which have a reputation for improving the blood. She buys them from an elderly woman who sells almost exclusively indigenous vegetables under a large red umbrella that protects her stock from the afternoon sun. She says her sales of such plants have climbed substantially over the past five years.

GLOBAL APPEAL

Green vegetables are not the only indigenous crops attracting researchers’ attention. In the 1990s, the US National Research Council (NRC) in Washington DC convened a panel to examine the potential of Africa’s ‘lost crops’, including grains, fruits and vegetables. Chaired by renowned agricultural researcher Norman Borlaug, the panel concluded that native plants held tremendous potential for improving food security and nutritional intake across Africa, and should be a greater focus for researchers⁴. Today, the World Agroforestry Centre in Nairobi is studying a range of Africa’s more than 3,000 indigenous fruit species, and finding that they are generally more nutritious, drought-tolerant and pest- and disease-resistant than their exotic counterparts.

But vegetables have gained the most notice, both in the marketplace and among researchers. Raymond Vodouhe, a plant breeder and geneticist with Bioversity International in Cotonou, Benin, says that his team’s work in West Africa has focused on domesticating wild vegetables. The hardy wild plants help African families to get through periods of drought or crop failure, but are threatened by deforestation and other types of land-clearing. By domesticating them, researchers can give farmers more-reliable access to indigenous vegetables so that they can better endure lean times.

The AVRDC is doing active research on native species in Asia and Oceania, as well



Nightshade and other indigenous vegetables helped to sustain Mary Abukutsa-Onyango when she was a child. She went on to pioneer research in these crops.

as Africa. “A rich diversity of indigenous vegetable species exists throughout these areas,” says Ebert, pointing to okra and African eggplant (*Solanum aethiopicum*) in Mali, bitter melon (*Momordica charantia*) and Malabar spinach (*Basella alba*) in India, and slippery cabbage (*Abelmoschus manihot*) in the Pacific Islands. “The challenge we face is selecting which indigenous vegetable species to study — with more than 2,000 plants that can be considered and consumed as vegetables, and very limited research funds, it’s a tough choice.” Less than 10% of the AVRDC’s roughly US\$20-million annual budget goes to studying indigenous vegetables, he says.

A main focus has been basic problems such as difficulties with germination and a lack of information about how best to store seeds. Indigenous vegetables are not up to modern farming standards for characteristics such as uniformity of seeds and yield, so there is a lot of catching up to do.

But efforts to improve indigenous vegetables could come at a cost, say researchers. If breeders focus only on increasing yields, they could accidentally eliminate nutritional benefits. And if farmers seek to drive up production through monocrop agriculture — planting just one crop — they risk losing some of the qualities that make these vegetables such a draw. Plots with single crops, for example, face higher risks of being completely wiped out by insects or diseases.

At the AVRDC’s office in Arusha in late February, vegetable breeder Fekadu Dinssa walks through a screened enclosure filled with plants used for breeding. He surveys a table

covered with starter trays of little amaranth plants from 57 breeding lines. In one tray, the plants are twice as tall as their neighbours, but their pale colour will not be popular in the market, he says. Dinssa wants to breed the fast-growing trait into other lines to develop a new type of commercially viable amaranth. It is a trial-and-error process that can take years.

STRENGTH IN DIVERSITY

As indigenous vegetables are planted in greater numbers, it will be a challenge to prevent less-common varieties from disappearing, say researchers. That could threaten the crops’ resilience, because different varieties can carry separate genes for resistance to pathogens and pests. Loss of diversity could also limit the vegetables’ appeal. In Kenya, for example, coastal communities tend to like giant African nightshade, whereas western communities prefer a variety with smaller leaves that has a much more bitter taste.

Some narrowing of choices has already happened. Simlaw Seeds in Nairobi, a division of Kenya Seed Company, sells only a couple of varieties each of amaranth and African nightshade, chosen because they are the most popular at the national level. “Of course it’s a concern, because practically speaking, we can’t promote them all,” says Abukutsa. She and other researchers compromise by promoting certain types while trying to preserve the full diversity in gene banks in Kenya and at the AVRDC. The researchers also encourage communities to continue growing the varieties they have traditionally favoured.

Calestous Juma, director of the Science,

Technology, and Globalization Project at Harvard University in Cambridge, Massachusetts, sees these efforts as crucial. And with advances in genomics, he says, researchers should seek ways to improve indigenous crops — by lengthening their shelf life, for example — and to use them in breeding other plants. “They may have traits that may be useful for other crops.”

Juma, who served on the NRC’s lost-crops panel, urges more agricultural research centres in Africa to study these vegetables. The work that Abukutsa and her colleagues are doing, he says, “should be done at every university”.

On a hot Wednesday morning in March, Abukutsa walks around the university campus to survey some of her students’ work. One has spread amaranth leaves in a wooden box in the sunlight to test how drying will alter the plants’ nutritional profile. Abukutsa stops to talk to another student standing amid dozens of rows of recently sprouted African nightshade plants, part of an experiment on their genetic diversity. “We’ve come so far,” Abukutsa says, “but there’s still so much to be done.” ■

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1. Abukutsa, M. O. O. *African Indigenous Vegetables in Kenya: Strategic Repositioning in the Horticultural Sector* (JKUAT, 2010).
2. Yang, R.-Y. & Keding, G. B. in *African Indigenous Vegetables in Urban Agriculture* (eds Shackleton, C. M., Pasquini, M. W. & Drescher, A. W.) Ch. 4 (Earthscan, 2009).
3. Habwe, F. O., Walingo, M. K., Abukutsa-Onyango, M. O. & Oluoch, M. O. *Afr. J. Food Sci.* **3**, 393–397 (2009).
4. NRC. *Lost Crops of Africa: Volume II: Vegetables* (National Academies Press, 2006).