Measuring arsenic in Bangladesh's rice crops

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Naturally-occurring arsenic in Bangladesh's groundwater has been identified as one of the world's great humanitarian disasters, with millions people at risk of cancers and other diseases from drinking water and eating rice irrigated with contaminated water. Now University of Massachusetts Amherst analytical chemist Julian Tyson and his student Ishtiaq "Rafi" Rafiyu are partnering with Chemists Without Borders (CWB) to develop a low-cost, easy-to-use test kit to measure arsenic in Bangladesh's rice supply, offering consumers information on exposure.

Tyson says, "One of the first steps in trying to make a difference and help people avoid this exposure has been to increase access to detection and remediation of arsenic-contaminated water, and many non-governmental organizations have been active for years in this area. Our current rice project with CWB builds on earlier work to develop a really low-cost procedure for testing water for arsenic. We hope our contribution to CWB's program of measurement and education will create more awareness and help make a significant difference to the people of Southeast Asia in the long run."

Tyson's analytical chemistry laboratory has for many years assisted environmental scientists and other chemists with tests for potentially harmful compounds of lead, cadmium, chromium, selenium and arsenic in soil and water. Last year, CWB approached the UMass Amherst lab to develop a simple, low-cost test for arsenic in rice, based on the groundwater test.

CWB president Ray Kronquist says the idea is not only to provide an accurate and reliable kit, but to teach chemistry students in Bangladesh who have access to a basic lab at the Asian University for Women (AUW) in Chittagong, to use it. These young interns will then provide arsenic exposure information and education on protective measures such as extra washing or choosing different varieties to local farmers, families, merchants and consumers.

Tyson recalls, "By an amazing coincidence, just a couple of weeks after the CWB request came in, a student approached me and asked if I had an independent study project for him in the spring semester. I always want to encourage that, and it turns out that Rafi is not only from Bangladesh, he grew up in Chittagong. He was the ideal person for the job, and I soon asked him to join the CWB project."

Rafiyu is now a summer intern supported by the Juanita F. Bradspies Fund for Undergraduate Research in Chemistry and will spend this summer conducting experiments to adapt an existing arsenic water test kit for testing rice samples. He and Tyson hope that by September or early fall, CWB will be able to use the adapted test kit at the AUW in Chittagong.

One of the key challenges in testing rice instead of water is that starch in the grain interferes with the reaction. One approach is to modify the chemistry by replacing zinc, the hydride-generation reagent, with borohydride. However, when Rafiyu adds this to the powdered rice paste, the reaction is extremely vigorous and must be slowed to detect any arsenic present.

Tyson and Rafiyu estimate that it will take scores of experiments to identify the optimum combination of reagent, concentrations and reaction conditions. Once that is solved, they plan to replace what is now a naked-eye evaluation of color on the arsenic test strip with a method that creates a digital image, for example with a cell phone camera, for analysis.

Once they put a new kit into the hands of the college interns in Bangladesh, CWB will help them to develop presentations about the health hazards of arsenic in rice at high schools and community centers. It is hoped that the young "agents of change" there can bring awareness and education to help people reduce their exposure. Tyson notes, "We need to address the problems at the village level, and the place to start is with accurate chemical measurement."

In communities with a high arsenic concentration in the water, the interns may try to connect people with organizations that can help the communities transition to safe water, for example. Tyson says different water levels or aquifers have different arsenic contamination, and it is often possible to find a shallower or a deeper one that is relatively free of arsenic. Using that water to irrigate rice can reduce arsenic contamination, as can rinsing rice before cooking, and cooking in excess water. Armed with local test results, consumers can make informed decisions about reducing arsenic intake, especially by infants and small children.

Tyson notes that current scientific thinking is that no arsenic exposure or intake is safe, but an "acceptable risk threshold" of 1 in 10,000 for an arsenic-induced cancer is generally viewed as sensible and achievable. This would correspond to a concentration of 100 parts per billion (ppb) in rice, based on modest consumption by an adult. "That's the equivalent of a grain of rice in about a quarter of a ton of rice," he notes. "Arsenic compounds are extremely toxic."

The analytical chemist hopes that government agencies around the world will step forward as the U.S. Food and Drug Administration did recently when it established a limit of 100 ppb for inorganic arsenic in baby rice cereal. "We need to extend that to all rice, which I believe should be labeled as to its arsenic content. Although the situation in Asia is serious, arsenic does occur in quite high concentrations in rice grown right here in the USA," he says.

Provided by University of Massachusetts Amherst