Benefits of Selenium-Rich Wheat

SDSU study attempts to take the guesswork out of producing high-selenium products.

Selenium (Se on the periodic table) is an element that is essential to human metabolism as a necessary constituent of some two dozen enzymes. While excess selenium levels can cause poisoning, selenium deficiency can also result in health problems.

Keshan disease is a potentially fatal form of cardiomyopathy (disease of the heart muscle) caused by severe selenium deficiency.

It was first observed in Keshan County in northeastern China in 1935 and has been found elsewhere in parts of the country where the selenium level in the soil is very low. Low soil levels of selenium also occur in New Zealand and Finland, where they can affect livestock production.

Selenium As a Dietary Supplement

Early in the 1930s, scientists in South Dakota discovered that much of the soil west of the Missouri River is naturally rich in selenium. The area that stretches from Nebraska, up through the Dakotas, and into Canada produces wheat and other grains that are exceptionally high in selenium.

The work of South Dakota Agricultural Experiment Station scientists Alvin Moxon, Oscar Olson, and Ivan Palmer shed considerable light on the selenium levels in the soil, food supply, and in livestock.

Supplementing diets with selenium has been found to reduce the risk of cancer.

“Ten years ago, we published the first results of a 13-year clinical trial, where we intervened with a selenium supplement in healthy older Americans,” says Dr. Gerald F. Combs, Jr., director USDA Human Nutrition Research Center, Grand Forks, ND (701-795-8456).

“By tripling their selenium intakes, total cancer mortality was reduced by half, and prostate and colorectal cancer incidences were reduced by two-thirds.”

Impact on milling industry. So what does this mean for the baking and milling industry? While it is unlikely that anyone in the United States is selenium deficient, Combs suggests that using selenium-rich wheat in bread, pasta, and other food products might be useful in reducing cancer risk. As he sees it, almost everyone in the country eats wheat, but not everyone can afford supplement pills or be motivated to take them.

Selenium-rich wheat products can provide selenium in a biologically available form to realize the health benefit of increased selenium intake.

While all currently available supplements contain 200 micrograms of selenium, Combs believes half of that dose would be effective, and for some people, even less is needed.

“Such doses can be obtained from crops produced on selenium-rich soils in the western United States,” Combs says.

“For instance, in Kansas, bread wheat runs about 0.1 ppm selenium. That’s 0.1 mg/1 kg of wheat.”

Combs continues, “In western South Dakota, bread wheat can have 10 ppm selenium, which is 100 times more. So a slice of high-selenium Dakota bread could provide the recommended daily allowance of selenium.”

Marketing Selenium-Rich Wheat

Prior to the current international interest, a few sales of high-selenium wheat were made in Europe.

Recent inquiries from Pacific Rim countries have sparked a renewed interest. The South Korean food industry is extremely interested in the health benefits of wheat from South Dakota.

“We’ve had a few trade teams come to South Dakota specifically to look at selenium-rich wheat, its production, and reliability of supply,” says Randy Englund, South Dakota Wheat Commission (SDWC) executive director (650-773-4645).

“Selenium is found in soil at different elevations and in different soil profiles, so you might harvest wheat with selenium levels of 10 ppm in one section of a field, but 20 feet further, you
are suddenly at 2 ppm,” Englund says.
He adds, “We need to come out with an audited product, so we can market it with a consistent selenium level.”

Product blends. Englund also adds that selenium is distributed throughout all parts of the kernel.

“If a miller wants to do some blending with another type of wheat or grain and still wants to achieve a certain level of selenium, he or she will need a formulation,” Englund says.
“ar other words, you can take wheat from an area that contains little selenium, blend it with a 4 ppm selenium wheat, and come up with a 2 ppm formulation.”

Recent Selenium Study
Four years ago, SDWC initiated and funded a research project in selenium-rich wheat at South Dakota State University (SDSU).
The SDSU project is led by Dr. Howard Woodard, a soil scientist. He is working in collaboration with Dr. Amir Ibrahim and Dr. Karl Glover, wheat breeders, and Dr. Padu Krishnan, a cereal scientist. This team also benefits from a cadre of international graduate students from South Korea and India.

Main objective. Mapping selenium levels in South Dakota’s soil is a major part of the project. Since selenium is not equally distributed in the soil, it is important to determine exactly which fields or even portions of fields will result in wheat that is highest in selenium.

“Our goal is to map the variability of selenium in the soil under various agronomic conditions and also determine selenium distribution within the wheat kernel,” says Dr. Krishnan, professor, SDSU Department of Nutrition, Food Science, and Hospitality (605-688-4040).

He adds, “We are also speciating the selenium to determine the physiological potent form in various mill streams.

“Finding selenium in wheat is like looking for a needle in a haystack, but we do this routinely,” Krishnan says. “We have to measure parts per million—one
part of the mineral mixed in with a million parts of wheat grain.”

“If you know the right science, you can find it,” he concludes.

Examining various classes. The team also looks at differences in Se levels due to wheat class, variety, and weather conditions.

“We are using hard red spring (HRS) wheat and hard red winter (HRW) wheat in our trials,” Krishnan says. “We have found no difference in selenium levels among different varieties so far in our trials.”

Milling trials. The second part of the equation is the milling process and results.

“We established early on that the distribution of selenium in wheat is not the same as other minerals,” says Krishnan. “For most minerals, if you take the bran out, you take out a big portion of the minerals.”

He adds, “We are abrading or pearling the grain, and as we do, we see the layered effect or how progressively the concentration of selenium goes down.”

He concludes, “The bottom line is that we have been able to get about 80% of the selenium to stay in the wheat endosperm that ends up in the flour.”

The team has also bumped up selenium concentrations by extracting a high-sele

According to Krishnan, another research question asks, “Is the pattern of distribution the same in high, medium and low-selenium wheat, and if so, how can the milling industry devise processes that ensure a predictable level of selenium in flour, bran, gluten, etc?”

Krishnan is finding a very high correlation between amino acids and selenium. About 40% to 45% of the selenium is bound in as seleno methionine.

“My interest is: if you have 100% selenium in the grain, then you mill it, where is the 100% going to? Does 20% go with the bran, and 80% stay in the wheat? That’s what the numbers are showing in the preliminary experimentation,” Krishnan says.

“One once we arrive at that magical number, we can specify to a miller that for a predictable selenium level of 80%, you need a yield of 80%,” Krishnan says.

“By controlling moisture and tempering, millers can get to where they need to be. But they need to know where the distribution is.

“Our target is to get consistent predictable selenium-rich flour, about 1 ppm, 2 ppm, so we can actually do something with it in industry. Ultimately, we want to say that a shipment of wheat has x-number of micrograms of selenium and be able to guarantee it,” Krishnan concludes.

Some of the wheat included in the SDSU study was milled at Northern Crops Institute, Fargo, ND, and Kansas State University, Manhattan. SDSU is also building a modest milling capability with the acquisition of a Quadrumat Senior Mill.

Sally Sologuk is a public relations/communications specialist for Northern Crops Institute at North Dakota State University, Fargo. She can be reached at 701-231-6538 or sally.sologuk@ndsu.edu.

“Finding selenium in wheat is like looking for a needle in a haystack.”

Dr. Padu Krishnan, SDSU.