Science Societies

How environment and genetics affect yield, nutritional profile of lentil

By Stacy Kish

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Photo courtesy of Adobe Stock/spline_x.

Lentils are an important food grain around the world and also provide many critical environmental services on the farm.

These small grains are now being tapped for their market potential in a new line of alternative-protein products.

New research in *Crop Science* seeks to identify the best cultivars for different soils and environments in Montana and to reveal how genetics and environmental conditions affect the resulting yield and nutritional profile.

Lentil is one of the oldest domesticated crops on record, but everything old is new again. This little grain has captured the imagination of a niche market expanding across supermarket aisles, meatless meat products.

According to the **Good Food Institute**, next-generation plant-based, protein-alternative meat, egg, and dairy products are a $7 billion market that is only expanding. From 2019 to 2020, the plant-based meat market, which is worth $1.4 billion, has increased in sales by more than $430 million. The nutritional profile of lentil grains provides the protein punch to make alternative-meat products healthful.

Lentil grains are rich in protein, starch, mineral nutrients, and vitamins, and the United States, the fifth-leading lentil producer in the world, grows 0.25 million tons of the crop every year. Despite all the health benefits, few studies have examined the role

environmental conditions and genetics play in the resulting yield and nutrient profile, especially in the major lentil-producing region of the Northern Great Plains.

From 2019 to 2020, the plant-based meat market, which is worth $1.4 billion, has increased in sales by more than $430 million. The nutritional profile of lentil grains provides the protein punch to make alternative-meat products healthful. Photo courtesy of Adobe Stock/Sundry Photography.

ASA and CSSA member Chengci Chen, professor at Montana State University and the Eastern Agricultural Research Center superintendent, led a team of researchers conducting a multi-site and multi-year cultivar trial in Montana. The team focused on evaluating how cultivars developed by breeding programs in the United States and Canada perform in the state. The aim of the study was to identify the best cultivars for different soils and environments and to reveal how genetics and environmental conditions affect the resulting yield and nutritional profile. The study findings were recently published in *Crop Science* (**https://doi.org/10.1002/csc2.20675**).

“We need to develop and test new cultivars that can not only grow [in the regions across the United States] but also have the quality characteristics that consumers want,” Chen says. “Producers need to have a specific cultivar that can adapt to their growing environments and produce a high yield with good quality so they can make a profit.”

The Study

In the study, the team examined four lentil cultivars—Avondale, CDC Richlea, CDC Imvincible, and CDC Maxim—at four Montana State University Agricultural Research

Centers (from west to east: Conrad, Bozeman, Moccasin, and Havre) and a farm in Richland, MT in the far northeastern portion of the state over three years.

“Montana is a big state,” Chen says. “From east to west and north to south, temperature, precipitation, elevation, and soil texture and profile varies. The temperature and precipitation also change from year to year.”

Avondale, a medium-sized, green grain, was developed by the USDA-ARS breeding program at Pullman, WA and released for production in the U.S. Northern Great Plains. In the study, it showed the greatest yield and stability across the varied environmental conditions of the five test areas. CDC Imvincible, a small green grain, and CDC Maxim, a small red grain, were developed by the Crop Development Centre in Canada. These two cultivars yielded less than Avondale across the Great Plains. CDC Richlea, a medium-sized, green grain also developed in Canada, was introduced to Montana and North Dakota and has been grown in the region for years.

Sorting Out Nutrients and Yield

Yield was highest at the Bozeman site and lowest at the Havre site. Beyond yield, nutrients varied greatly across the five locations.

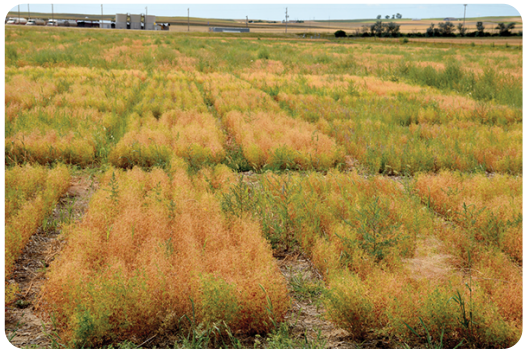
The Moccasin and Havre sites produced lentils with the highest protein concentration (>260 g/kg), and the cultivar CDC Imvincible produced the most protein (265 g/kg). CDC Richlea produced the lowest protein concentration (246 g/kg).

The highest starch concentration was grown in Richland and Moccasin (>451 g/kg). The starch concentration also varied by cultivar but in the opposite order of the protein ranking, with 456 g/kg starch in CDC Richlea and 436 g/kg starch in CDC Imvincible.

Mineral nutrients, which also varied by cultivar and site location, may not be front of mind for most people, but these components are important for health and well-being.

“In many developing countries, people suffer health issues due to malnutrition when they lack key nutritional minerals, like iron and zinc,” Chen says. “We can enrich certain crops, like lentils, in mineral nutrients through agronomic practices or plant breeding to combat [these deficiencies].”

The researchers found the Bozeman location produced lentils with the highest iron concentration, which is essential for the healthy development of hemoglobin. The Richland site produced lentils with the highest concentration of zinc, an important mineral nutrient for a healthy immune system. Havre produced lentils with the highest selenium concentration, which has shown to prevent cancer.



Four lentil cultivars were studied at four Montana State University Agricultural Research Centers and a farm in Richland, MT over three years. Photo courtesy of Chengci Chen.

The Importance of Plant Breeding

This study illustrates how plant breeding and production site can influence lentil nutrient concentrations, but juggling all of this data can be tricky. While CDC Imvincible grown at the Havre site produced the highest concentration of protein, the yield was low. It is essential to put the right cultivar in the right location to meet market needs but also produce a yield to sustain growers. This complex calculation brings us back to the future of plant protein in alternative-meat products.

“If we can determine if protein is controlled by genetics or the environment, we can breed and select the best cultivar for a given region to produce consistently higher protein,” Chen says. “The protein can be used not only for new products that use protein-rich grains but also to extract protein as a food ingredient to enrich other

products [on the market]."

This effort is part of larger push by the USDA Pulse Crop Health Initiative (**https://bit.ly/3v42Jyd**), which provides solutions to critical health and sustainability challenges by promoting the health and nutritional benefits of regular pulse consumption, including lentils, peas, chickpeas, and beans.

Dig deeper

Read the original *Crop Science* article, "Evaluation of Environment and Cultivar Impact on Lentil Protein, Starch, Mineral Nutrients, and Yield," here: **https://doi.org/10.1002/csc2.20675**.

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