Zapped, infrared-heated lentils are more nutritious and 'greener' to process

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Left to right: USask doctoral students Tahereh Najib, Mehdi Foroushani, and USask College of Engineering researcher Dr. Venkatesh Meda (PhD) at the Canadian Light Source synchrotron. Credit: University of Saskatchewan

By combining heat from microwaves and infrared energy, University of

Saskatchewan (USask) researchers have uncovered a new, more energy efficient way to process lentils, making them more nutritious and digestible. The findings may result in more value for consumers, food processors, ingredient manufacturers, and producers.

Processing red lentils with a specialized combination infrared microwave system—a countertop device that allows heating by microwave and radiant heat simultaneously—the USask research team was able to substantially improve how easily these lentils could be digested.

"The process makes these macromolecules—starch and protein—more accessible to enzymes in our bodies," said Mehdi Foroushani, USask doctoral student and first author on the study published in the journal *Food Chemistry Advances*.

By tweaking the amount of moisture in the lentils, and the amounts of microwave and infrared energy, the research team was able to make more than 96% of the starch digestible, and more than 85% of the protein digestible, measured by how quickly the product dissolves in vitro. In raw lentils, less than 69% of starch is digestible and less than 80% of protein is digestible.

To better understand what happened at the molecular level and examine it in the finest detail possible, the research team analyzed the lentil samples using USask's Canadian Light Source synchrotron.

"Starch has a smooth surface," said USask doctoral student Tahereh Najib, co-author of the study. "We make it kind of rough, so it's more accessible by enzymes and the starch can be better broken down."

More than two million tons of lentils are produced on average each year in Canada, the world's biggest producer, with the majority produced in Saskatchewan. Lentils are harvested, cleaned, and graded before

packaging or further processing. Most are cooked and consumed as a whole grain, but a growing volume of lentils is dried and turned into a powder to isolate proteins from starches and used as a food additive.

"Our process takes 200% less drying time," said USask College of Engineering researcher Dr. Venkatesh Meda (Ph.D.), principal investigator on the study. "The unique nature of this energy method is that there is no input of chemicals used for drying, there is no output in terms of release of greenhouse gases."

In microwaving, heat is generated from the center of the lentil and radiates outward—moisture and heat escape to the outside environment. By simultaneously roasting the surface of the lentils with infrared heat, the research team was able to increase the overall efficiency and better seal in the microwave heat.

"By having more plant-based alternative food ingredients in our diet, one can also reduce our environmental footprint by fulfilling our need for proteins from plant sources," said Meda.

The ideal setting of lentil moisture, microwave energy intensity, and infrared roasting depends largely on how the lentil flour will be used.

"Modified lentil flour can be a great source of plant-based ingredients for our dietary and nutritional needs, and our kitchen and food processing operations," said Meda. "Lentil flour serves as an additive or substitution to our food system to not only make the food nutritious but also preserve its acceptable texture."

The USask-processed lentils have not yet been assessed or approved for official trials involving human or animal consumption, for which a commercial kitchen is required. While the texture may be acceptable, how does the zapped lentil flour taste?

"At home we have been using it, and the aroma has improved to 'acceptable,' and not deteriorated compared to any other commercial variety," said Meda. "We're happy to report there is not much loss in any of the sensory qualities: color, texture, aroma."

Currently, the lentil flour is processed in very small batches—only 50 grams. The next steps in the research involve improving the flavor, scaling up to process larger amounts of lentils, applying the process to other legumes and oilseeds, and examining whether the technique could also improve seed quality for germination.

More information: Mohamad Mehdi Heydari et al, Investigating starch and protein structure alterations of the processed lentil by microwave-assisted infrared thermal treatment and their correlation with the modified properties, *Food Chemistry Advances* (2022). DOI: 10.1016/j.focha.2022.100091

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