Apple chips moisture analysis made easy with near-infrared spectroscopy

November 10 2021, by Marianne Stein

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Dried snack foods such as apple chips are a convenient alternative to fresh fruit, providing longer shelf life and easier storage. Consumers increasingly demand product variety, so companies coat such snack

foods with fruit and vegetable powders to enhance taste and sensory appeal.

A new study from the University of Illinois explores the drying process of coated and uncoated apple chips using near-infrared (NIR) spectroscopy to measure moisture content in real time. NIR technology greatly enhances the speed and accuracy of measurements, the researchers say.

The purpose of coating is to make dried apple chips more functional and nutritional, as well as more appealing to eat, explains Ragya Kapoor, graduate student in Food Science and Human Nutrition (FSHN) at U of I and lead author on the paper.

"The idea is to get school-aged children to include apple chips in their diet. We use a cranberry powder coating to make the apple slices more attractive in terms of color and taste," Kapoor says. "We dip the apple slices in a liquid-based solution for 60 seconds twice, and then conduct the hot air-drying operation."

The researchers check the moisture content at various points throughout the drying process with miniature NIR spectroscopy to ensure the chips are dry enough.

NIR technology offers many advantages compared to standard monitoring techniques, says Mohammed Kamruzzaman, assistant professor in the Department of Agricultural and Biological Engineering (ABE) at U of I and co-author on the paper.

"In traditional methods, you take samples from the production for lab analysis. The process takes at least 24 hours, the samples are destroyed, and some analyses require harsh chemicals," Kamruzzaman notes.

NIR spectroscopy takes a few seconds, does not require the removal of samples, and uses no chemicals.

"NIR is highly accurate, it is very fast, does not destroy the samples, and does not use chemicals. It is sustainable, green technology. Traditional lab techniques need experts to handle the equipment and interpret the data. NIR is easy to use, and almost anyone can handle the instrument and take the measurement with just a few minutes of training. And the equipment is small and portable."

NIR works by scanning the product with invisible light, Kamruzzaman explains.

"With our eyes we can see the size, shape and color of food, but we cannot see the nutritional composition. The near-infrared light reads the chemical bonds in the food, so you can analyze any biological matter and determine features such as moisture content, protein, fat, fiber, or carbohydrates. The NIR spectroscopy will give you many data points; we extract the data and use machine learning to interpret the results," he states.

"The combination of NIR spectroscopy and machine learning is very powerful."

Kapoor, Kamruzzaman, and study co-authors Amir Malvandi, graduate student in ABE, and Hao Feng, professor of food and bioprocess engineering at U of I, had two main research goals. They wanted to explore edible coating on apple slices and test the use of NIR spectroscopy to monitor the drying process for coated versus uncoated slices.

"The moisture content is different for coated and uncoated samples, and we wanted to see how drying behavior differs for them. We found that

with NIR technology we are able to differentiate between the two samples based solely on the difference in their composition," Kapoor explains.

The researchers say NIR spectroscopy can greatly enhance production efficiency.

"NIR allows you to see your product's changing moisture content in real time. You can continuously monitor the drying process, observe the amount of dry matter, and decide the right time to stop," Kamruzzaman states.

The Department of Food Science and Human Nutrition and the Department of Agricultural and Biological Engineering are in the College of Agricultural, Consumer and Environmental Sciences, University of Illinois.

The paper, "Real-time moisture monitoring of edible coated apple chips during hot air drying using miniature NIR spectroscopy and chemometrics," is published in *LWT—Food Science and Technology*.

More information: Ragya Kapoor et al, Real-time moisture monitoring of edible coated apple chips during hot air drying using miniature NIR spectroscopy and chemometrics, *LWT* (2021). DOI: 10.1016/j.lwt.2021.112602

Provided by University of Illinois at Urbana-Champaign