UCD Impact Case Study

A fresh look at freezing foods: new technology to preserve nutrients

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SCIENTIFIC · HEALTH · TECHNO-LOGICAL · ACADEMIC · ECONOMIC

SUMMARY

We all know the importance of eating fresh food, but could frozen food be just as good for us? That depends on how quickly and effectively the food has been frozen, and whether its nutrients have been protected on its journey to us.

Professor Da-Wen Sun, Professor of Food and Biosystems Engineering at UCD School of Biosystems and Food Engineering, has written key textbooks for the food industry and has received many international accolades for his work on refrigeration and freezing technologies.

He has developed a method that uses ultrasound during freezing to make the process more effective, lessening damage caused by ice crystals and protecting nutrients within foods. The method is now under consideration by academic and industry food researchers, and could ultimately help to protect nutrients in food processing and storage and improve human health through more effective nutrition.

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Fresh or frozen?

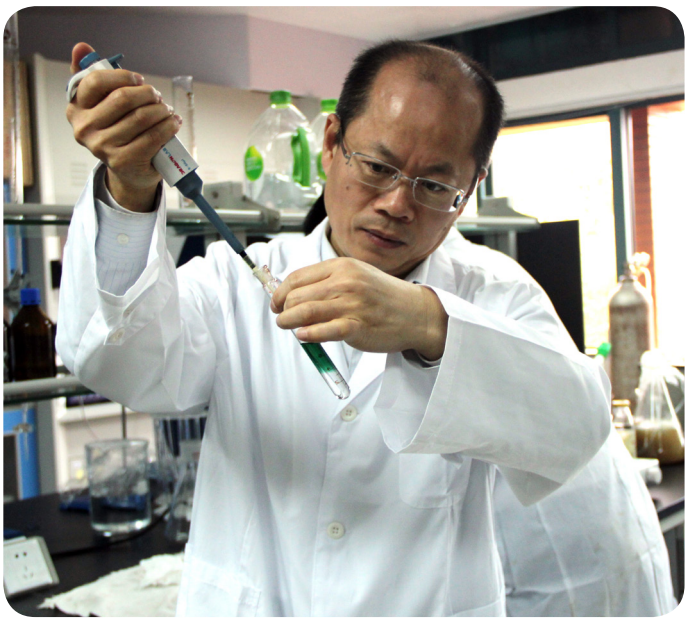
We all know that fresh fruit and vegetables are good for us. But could their counterparts in the frozen section be just as nutritious and therefore more convenient?

"A lot of people think that fresh food taken from the supermarket is better than frozen, but that is not always true," explains Professor Da-Wen Sun, Professor of Food and Biosystems Engineering at UCD School of Biosystems and Food Engineering, who has developed technology for the food industry to improve the effectiveness of freezing to protect the food structure and lock in nutrients.

"Fruit and vegetables are living tissues, and they remain alive even after harvest," says Professor Sun. "They still function biochemically, and this affects the quality of the food, and they lose water. So, when you pick up fresh food in the supermarket, you don't know how long those processes have been affecting the quality in the food during transportation and storage."

On the other hand, if foods are frozen quickly after harvest, these processes of respiration and transpiration are slowed down to the point of almost stopping. "In this way we freeze the freshness," says Professor Sun. "And if done properly, then the frozen food can be better nutritionally than fresh food that is left for long periods in transport and storage."

The big problem during freezing though is the growth of ice crystals within the food, which can damage internal structures.



"Fruits and vegetables contain a lot of water, maybe 80-90%, and the freezing process converts this liquid to a solid," explains Professor Sun. "During this conversion, the water 'nucelates' to form crystals and these ice crystals grow."

These ice crystals are the main factor affecting quality in frozen foods, according to Professor Sun, because they can damage the internal structure of the food, such that when the food thaws out, the nutrients drip out of the food along with the water: "So we want to freeze the food without the internal damage, and this will **preserve the nutrients within the food**."

At present, the food industry often uses a blast of cold air or extremely cold liquid nitrogen or carbon dioxide to freeze foodstuffs, but that will only work well to a point, notes Professor Sun.

"No matter how good these techniques are, they cool surface quickly but then as you move from surface to inside the rate of freezing is controlled by conduction," he says. "And foods such as vegetables and meats are poor conductors of heat, so the heat gets removed slowly as you move to the inside of the food."

That means that small-sized foods, such as peas and sweetcorn kernels, can be frozen with relative ease, but that conventional freezing is more challenging with larger foodstuffs such as potatoes and apples.

Ultrasound technology to assist freezing

This is where Professor Sun's technology comes in. In the early 2000s he and his group at UCD published details of a new approach: using ultrasound to assist freezing.

"Ultrasound has the ability to produce bubbles of vapour in a liquid, this is called cavitation," he explains. "And when we apply ultrasound during the freezing process it can help to reduce the size of ice crystals that form in the internal structure of the food."

Professor Sun and his team were the **first to develop this freezing technology internationally**, and their experiments showed that **using ultrasound when freezing helped to preserve the internal structure of many larger fruits and vegetables**, including potatoes and apples.

Not all foods suit the new freezing technology – meat, chicken and foods with more porous internal structures do not demonstrate the same level of benefit – but where it works, the results are good.

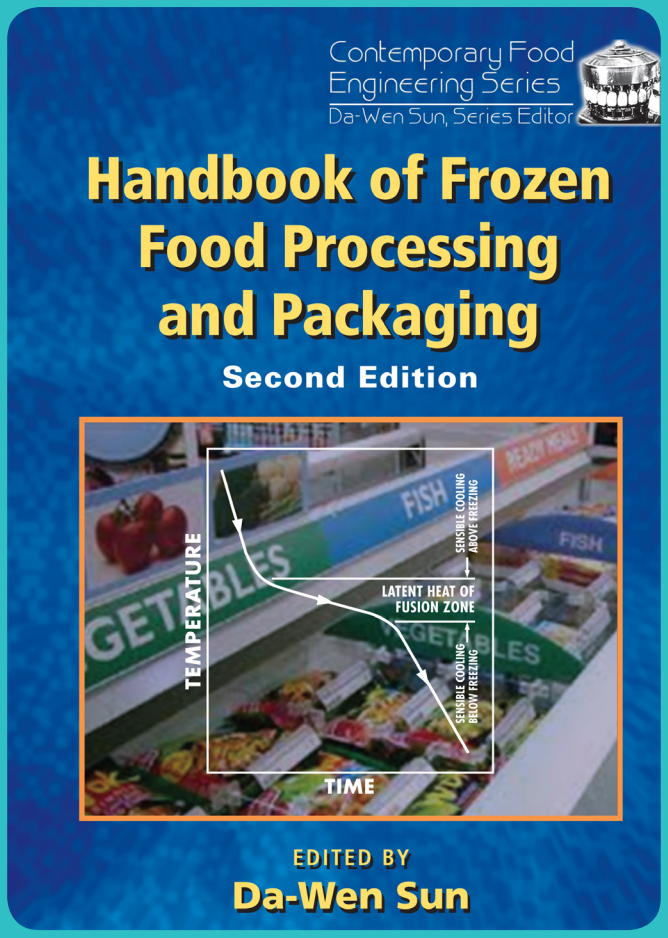
"We were able to show that, compared to conventional methods, the ice crystals that form are smaller with ultrasound-assisted freezing," explains Professor Sun. "We could see that **the damage inside the foods was minimised**."

Professor Sun's team at UCD worked as part of a European consortium to develop the technology for industry, building a **working prototype of an ultrasound-assisted freezing device**. "We were able to show industry that it can work," he says.

The potential impact of being able to freeze foodstuffs in a way that more effectively locks in nutrients is enormous: a recent report from Market Research Future predicted that the global frozen fruits and vegetable market will grow at an annual rate of 5.34% and reach 751 million tons by 2027.

Technologies to improve the quality of those frozen foodstuffs will help to **improve the nutrition they can deliver**, according to Professor Sun, though he notes that the uptake of ultrasounds-assisted freezing will not be instant. "The technique is very promising but it will take time for industry to adopt it," he says. "Several countries, including China, have now listed ultrasound-assisted freezing on their agendas for research."

Professor Sun, who directs the UCD Food Refrigeration & Computerised Food Technology group in UCD, is a **global authority in food engineering research and education**, and has worked on numerous technologies to improve food processing.



He is the editor of Handbook of Frozen Food Processing and Packaging, a **major text in the field**, and his writings have become **standard references in the fields of computer vision, computational fluid dynamics modelling and vacuum cooling**. He is founder and editor-in-chief of the journal Food and Bioprocess Technology.

Among his many awards, in 2013 Professor Sun became the **first person from outside the United States to be awarded the Frozen Food Foundation Freezing Research Award**, in recognition of outstanding contributions to the field of food safety through freezing research.

In 2016, he was conferred with the title of **International Commission of Agricultural and Biosystems Engineering (CIGR) Honorary President for his distinguished services** during the period 2011-2016 as President of the Commission.

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