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PEELING BACK THE SCIENCE OF CITRUS FRUITS

A conversation with **YANG SHAN,** a member of Chinese Academy of Engineering

From sweet mandarins and sour lemons to complex pomelos and tart kumquats, citrus fruits have an agricultural story stretching back thousands of years and are used for much more than just food. Their by-products and functional components are used to both preserve and make medicines, soaps and shampoos. As one of the most widely grown categories of fruit around the world, citrus fruits have long been of interest to researchers. One of them is food scientist, Yang Shan, who has been studying them for nearly 40 years.

Why have you focussed on citrus?
Global output of citrus fruits has reached more than 159 million tonnes, with 55 million tonnes of that from China, which also produces more than 10 million tonnes of citrus by-products, rich in functional components. Since I joined Hunan Academy of Agricultural Sciences in 1984, I've been devoted to revealing the most efficient use of these components.

What are functional components in citrus fruits?
The most commonly used functional components in citruses include pectin, flavonoids, essential oils and synephrine.

Pectin is a soluble fibre often used as a thickener in jams and jellies, and 70% of the world's supply of such thickener is extracted from citrus peel.

Flavonoids are bioactive compounds regarded as natural antioxidants, which are used in many health-promoting products; Essential oils are often used in household chemical products for their fragrance and anti-microbial effects.

Synephrine, a bitter orange extract, has been proved to limit lipid accumulation by inducing the formation of brown fat cells in mice. Further research into this bioactive compound might shed light on potential therapeutics for obesity.

Tell us about your research?
My research has been focussed on how to extract functional components of citrus fruits in an efficient and environmentally friendly fashion and to make best use of them.

For example, pectin is typically extracted by using hot water, which is time consuming and involves hazardous organic solvents. As an alternative, we developed a technique which uses microwaves, which helps break down cells; and surfactants — chemical compounds that can reduce tension at the surface or interface between two different substances — which eliminate the need for organic solvents. Using this method, we have observed reduced extraction time, higher yield and higher pectin quality, suggesting this is a much more efficient route for industrial-scale production.

When it comes to the biologically unstable essential oil in lemons, we optimized a technique to encapsulate it in nanoscale emulsions, using ultrasonic sound waves. This can improve its stability, laying the foundation for wider use in the cosmetics and food industries. Furthermore, we demonstrated the use of hesperidin, a flavonoid; and pectin as reductants and stabilizers in the production of silver nanoparticles. These are antibacterial nanomaterials with biomedical applications.

What are your findings about flavonoids?
There are more than one hundred kinds of flavonoids in citrus fruits. We have been studying their antioxidant properties and exploring biosynthesis, the generation of natural products through chemical reactions, for mass production. We've found that the chemical structure — mainly the position and number of the functional methoxy and hydroxyl groups on the benzene ring— is related to their antioxidant activity. We've been studying this link and exploring the possibility of biosynthesizing citrus flavonoids, such as naringin and hesperidin, which are hard to extract from fruit and can't yet be produced at sufficient quantities to meet growing market needs.

How can we improve the storage and processing of citrus fruits?
We developed a quick-freezing technology to keep citrus fruits fresh during storage. Rather than using chemical preservatives, we studied the cell structure and water content of citruses and found a way to make them freeze very rapidly so ice crystals remain small and don't rupture cell membranes. We also developed a low-temperature sterilization technique. Rather than using 100 °C steam, which might destroy the vitamins, we found that 83 °C can also sterilize citrus, and we also managed to halve the amount of water needed for sterilizing and cleaning the fruit.

What's next step for your citrus research?
Up to 30% of citrus fruit goes to waste. So, one of my focuses is to optimize storage and processing techniques to make full use of the fruit that is harvested. I will also continue to explore the functional activities of those ingredients, hoping to discover more of their benefits to human health. Another focus will be biosynthesis of flavonoids to reduce costs and encourage mass production.

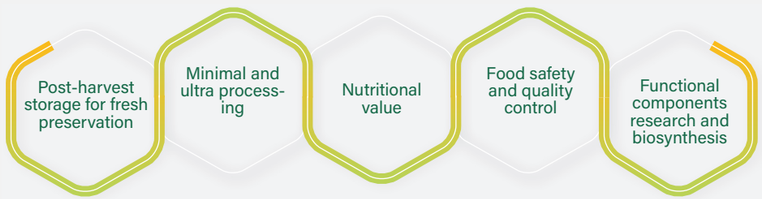
A fresh look at the science of fruit and vegetables

The **Hunan Academy of Agricultural Sciences** started as an agricultural experiment station in 1901. The renowned scientific research institution is dedicated to finding the latest knowledge to enhance better cultivation of various fruits, vegetables, rice, tea and other crops.

Its team dedicated to the study of fruit and vegetable storage, processing, and quality control, started in 1986, and now consists of 39 members with a wide range of expertise.

Hunan Academy of Agricultural Sciences

Comprehensive research areas:



Advanced research platforms:

4 national laboratories and R&D centres and **6** provincial key research platforms

Honours and awards:

2 national innovation team and **1** provincial science and technology innovation team award

Second prize in State Science and Technology Progress Award for twice, Guanghua Engineering Science and Technology Award of the Chinese Academy of Engineering, first prize in provincial science technology awards for three times

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2 national-level talent and **7** provincial-level talent

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Published more than **300** high-quality papers

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