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From intelligent vegetable film to emulsifier from beer waste: Recycling recipes from Singapore

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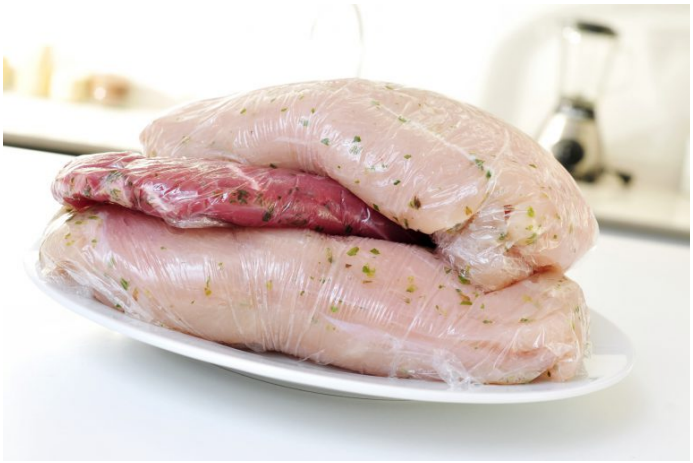
Singapore has long been a candidate for the role of leader of food innovation: it was the first country to market cultured meat (chicken) and is a leader in the production of hydroponic vegetables on roofs. Right here, researchers from the local Nanyang Technological University published, at the end of last December, two studies on the reuse of by-products of corn and cereal processing. These are important innovations that could make a significant contribution to implementing *upcycling* , that is the processes through which not only waste is not thrown away, but is transformed into products with a higher value than the starting material.

The first describes an 'intelligent', biodegradable and sustainable film for food preservation, obtained from zein, a protein found in corn, combined with starch, cellulose and essential oils from aromatic herbs such as thyme, and acid. citric present for example in citrus fruits. As illustrated in *ACS Applied Materials and Interfaces,* the film, which is formed by passing a small electric current through the mixture of the basic components, releases tiny amounts of natural antiseptics when the humidity rises and in the case of enzymes produced by microorganisms present in and on the surface of the food, and therefore is activated only when necessary. This is why it is 'smart', lasts a long time and can be used several times.



The film is potentially usable for the preservation of foods such as meat and fish

In tests conducted together with co-authors, researchers from Harvard University, the film was shown to be capable of killing many pathogenic species for humans such as *Escherichia coli, Listeria monocyotgenes* and several types of fungi. In addition, the material ensured that a strawberry sample was kept at room temperature for seven days, compared to four days in the control sample packaged in classic plastic packaging. Its characteristics make it potentially usable for meat, fish and other foods.

Vegetable film could replace at least part of the plastic waste associated with the food supply chain: in 2018 alone, Singapore produced 1.76 million tons of waste, a third of which was packaging, in turn plastic for 55 % of the total. Furthermore, the university already has agreements with the producers of hydroponic vegetables on the roofs to obtain the starting materials from them, to then make them in the form of film for their products, and thus constitute a cycle with very low impact and high value of *upcycling* .

The researchers successfully produced a mayonnaise by replacing the egg with an emulsifier derived from brewing waste

In the second study , published in *Food Chemistry* , the researchers described the transformation of beer production waste into an antioxidant and protein-rich emulsifier, which could replace eggs and dairy products in numerous industrial products such as mayonnaise and salad dressings.

In this case they used a very common process because it is central to the food culture of the country: fermentation. *In fact, by adding Rhizopus oligosporus* to the waste, used in the production of soy tempeh, a protein hydrolyzate is obtained which, once dried, can be directly used as a vegetable emulsifier. Compared to the more common mayonnaises, the one produced with this substance proved to be richer in proteins and essential amino acids, comparable in terms of fat and calorie content, indistinguishable in taste and better in terms of texture and palatability. Now the vegetable emulsifier will also be tested in numerous other foods such as sweets and ice cream, vegetable drinks and even cosmetics, and there is no reason to think that it is not as versatile and efficient.

Globally, the authors conclude, 39 million tons of beer waste are produced every year, the vast majority of which ends up in waste, is degraded and fuels greenhouse gas emissions. If they were reused, as is only the case today, even more so in an *upcycling* process like this, the impact would certainly be significant.