Silk keeps fruit fresh without refrigeration

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Half of the world's fruit and vegetable crops are lost during the food supply chain, due mostly to premature deterioration of these perishable foods, according to the Food and Agriculture Organization (FAO) of the United Nations.

Tufts University biomedical engineers have demonstrated that fruits can stay fresh for more than a week without refrigeration if they are coated in an odorless, biocompatible silk solution so thin as to be virtually invisible. The approach is a promising alternative for preservation of delicate foods using a naturally derived material and a water-based manufacturing process.

The work is reported in the May 6 issue of *Scientific Reports*.

Silk's unique crystalline structure makes it one of nature's toughest materials. Fibroin, an insoluble protein found in silk, has a remarkable ability to stabilize and protect other materials while being fully biocompatible and biodegradable.

For the study, researchers dipped freshly picked strawberries in a solution of 1 percent silk fibroin protein; the coating process was repeated up to four times. The silk fibroin-coated fruits were then treated for varying amounts of time with water vapor under vacuum (water annealed) to create varying percentages of crystalline beta-sheets in the coating. The longer the exposure, the higher the percentage of beta-sheets and the more robust the fibroin coating. The coating was 27 to 35 microns thick.

The strawberries were then stored at room temperature. Uncoated berries were compared over time with berries dipped in varying numbers of coats of silk that had been annealed for different periods of time. At seven days, the berries coated with the higher beta-sheet silk were still juicy and firm while the uncoated berries were dehydrated and discolored.

Tests showed that the silk coating prolonged the freshness of the fruits by slowing fruit respiration, extending fruit firmness and preventing decay.

"The beta-sheet content of the edible silk fibroin coatings made the strawberries less permeable to carbon dioxide and oxygen. We saw a statistically significant delay in the decay of the fruit," said senior and corresponding study author Fiorenzo G. Omenetto, Ph.D. Omenetto is the Frank C. Doble Professor in the Department of Biomedical Engineering and also has appointments in the Department of Electrical Engineering and in the Department of Physics in the School of Arts and Sciences.

Similar experiments were performed on bananas, which, unlike strawberries, are able to ripen after they are harvested. The silk coating decreased the bananas' ripening rate compared with uncoated controls and added firmness to the fruit by preventing softening of the peel.

The thin, odorless silk coating did not affect fruit texture. Taste was not studied.

"Various therapeutic agents could be easily added to the water-based silk solution used for the coatings, so we could potentially both preserve and add therapeutic function to consumable goods without the need for complex chemistries," said the study's first author, Benedetto Marelli, Ph.D., formerly a post-doctoral associate in the Omenetto laboratory and

now at MIT.

More information: Marelli, B. et al. Silk Fibroin as Edible Coating for Perishable Food Preservation. *Sci. Rep*. 6, 25263, DOI: 10.1038/srep25263 (2016)

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