

Innovative Food Processing for Improved Health, Safety and Sustainability of Fruits and Vegetables







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USDA, ARS Locations in the U.S.



ARS MISSION

ARS conducts research to develop and transfer solutions to agricultural problems of high national priority and provides information access and dissemination to:

- Ensure high-quality, safe food and other agricultural products,
- Assess the nutritional needs of Americans,
- Sustain a competitive agricultural economy,
- Enhance the natural resource base and the environment, and
- Provide economic opportunities for rural citizens, communities, and society as a whole.





Harvard Kennedy School

"Technological innovation is essential for fostering economic growth, enhancing global competitiveness, and protecting the environment."











Forming Technology (McHugh and Huxsoll)





18 Clinical Trial with Children's Hospital Oakland Research Institute – Dr. Bruce Ames



DARK CHOCOLATE BLUEBERRY FRUITRIENT

Two bars a day added to normal diet:

Increased HDL cholesterol and Decreased LDL cholesterol
Improved "size profile" of both HDL and LDL cholesterol
Decreased triglycerides, homocysteine, C-reactive protein
Reduced blood pressure
Increased insulin sensitivity
Improved insulin resistance
Decreased fasting glucose level
Increased satiety and Decreased waist circumference
Improved lung function





Fruit and Vegetable Edible Films



Antimicrobial Phytochemicals

Plant essential oils
Active compounds of essential oils
Flavonoids
Phenolic compounds



(in oregano essential oil)

Cinnamaldehyde (in cinnamon essential oil)

0







Roberto Avena-Bustillos places an antimicrobial edible film into a small dish within a larger dish of spinach leaves inoculated with *E. coli* O157:H7. The larger dish is then sealed to evaluate the efficacy of antibacterial vapors released from the film.

USDA

Applications of Nanoscience to Edible Films Ten Years of Collaboration with Brazil



Dr. Luiz H. C. Mattoso Dr. Henriette Azeredo Dr. Marcia Regina de Moura Aouada Dr. Francys Moreira Mr. Caio Otoni

Over seven peer-reviewed manuscripts Several awards Grant proposal from USDA, NIFA



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MushroomCouncil.org



Bart Minor, President Mushroom Council "Did you know mushrooms can be treated with UV light to produce vitamin D?"

Innovative Mushroom Processing to Develop a Novel, Value-Added Source of Vitamin D





LITERATURE REVIEW

 Previous studies on UV treatment of mushrooms at low doses for long times.

 No one investigated commercial potential of technology.

Still many questions to be answered.

How to treat mushrooms with UV? UV-B or UV-C?





Preliminary Results Led to CRADA with Monterey Mushrooms



CRADA

•Develop Commercially Viable High Intensity/Short Time Process

•Study Effects of Postharvest Time on Vitamin D Formation

•Evaluate Degradation During Storage

Quantify Sensory Properties



UVB Treatment at Three Intensities, Three Doses and Treated 1 and 4 Days after Harvest

| dose | 1 me | | | | | | |
|----------|----------|----------------------------|----------------------------|-----------------|-----------|---------|---------|
| (Jiam) | (min) | 1 day | 4 day | 1 day | 4 day | 1 day | 4 0 8 4 |
| | | inter | sity = 0.46 mW | cm ² | | | |
| 0 | 0 | 0.01 | 0.01 | 0.07 | 0.07 | 0.67 | 0.67 |
| 0.5 | 18.1 | $3.75 \pm 0.18^{s/s}$ | 3.55 ± 0.17^{h} | 30.87 | 29.22 | 308.7 | 292.2 |
| 1.0 | 36.2 | $4.53 \pm 0.21^{\circ}$ | 4.30 ± 0.20^{6} | 37.25 | 35.40 | 372.5 | 354.0 |
| 1.5 | 54.4 | 7.29 ± 0.34^{b} | $7.20 \pm 0.34^{\circ}$ | 59.89 | 59.27 | 598.9 | 592.7 |
| | | inter | sity = 0.75 mW | cm ² | | | |
| 0 | 0 | 0.01 | 0.01 | 0.07 | 0.07 | 0.67 | 0.67 |
| 0.5 | 11.1 | 3.48 ± 0.16^{h} | 3.35 ± 0.16 ^h | 29.61 | 27.58 | 296.1 | 275.8 |
| 1.0 | 22.2 | 5.58 ± 0.26 ^{4,*} | $5.33 \pm 0.25^{\circ}$ | 45.89 | 43.84 | 458.9 | 438.4 |
| 1.5 | 33.3 | 7.2 ± 0.34 ^b | 7.08 ± 0.33^{b} | 59.27 | 58.24 | 582.7 | 582.4 |
| | | Inter | nsity = 1.0 mW/s | :m² | | | |
| 0 | 0 | 0.01 | 0.01 | 0.07 | 0.07 | 0.67 | 0.67 |
| 0.5 | 8.3 | $3.83 \pm 0.18^{\mu h}$ | $4.43 \pm 0.21'$ | 31.49 | 36.43 | 314.9 | 364.3 |
| 1.0 | 16.7 | $6.2 \pm 0.29^{\circ}$ | 6.05 ± 0.28°, ^d | 51.04 | 49.90 | 510.4 | 498.0 |
| 1.5 | 25.0 | $7.43 \pm 0.35^{a,b}$ | 7.98 ± 0.38^{4} | 61.12 | 65.65 | 611.2 | 656.5 |
| 1.040 | | | | | | | |
| · Din | erent le | eters indicate a s | ignificant otheren | ce in de | scenan | gorderi | rom ra |
| mough | т. (tea | st significant diffe | rence at $p \le 0.0$ | 5). * Bas | section a | serving | 01 84 (|
| of fresh | mushro | com having a mo | isture content of | $90.2 \pm$ | 0.5%. | | |

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Sensory Properties of UV-B Treated Mushrooms

•Spectrophotometric Analyses – L, a, b

•Texture Profile Analyses

•Sensory Analyses

Novel Ultraviolet B Process Being Used Nationwide on All Mushroom Varieties by #1 Mushroom Producer in U.S.





Remaining Question?

Human Bioavailability

Would consuming one serving of cooked, UV treated mushrooms per day for 6 weeks increase serum 25(OH)D2 levels and improve vitamin D status (assessed by measuring total 25(OH)D) in healthy adults?

Charles Stephensen, Research Leader, WHNRC



MushroomCouncil.org



Innovative Ultraviolet Processing to Enhance Nutritional Value of Specialty Crops





Ultraviolet B treatment results in more than doubling of total soluble phenolics and antioxidant content in baby carrots.

AFRI Grant, USDA-NIFA, 2009-2012

Effect of UV-B Exposure on TSP and AC of Carrot at Different Cutting Stage





Infrared and Solar Processing Reduce Water and Energy Use

In California (California Energy Commission, 2005)

- Food processing industry is third largest industry using energy and water, 80% of which is from the fruit and vegetable industry
- Over 70% of the energy used by the fruit and vegetable industry comes from heating operations (blanching, drying, pasteurization, etc.)





Innovative Foods

Mobile Infrared Demonstration Unit – Zhongli Pan

- Purpose
 - Demonstrate the new IR processing methods for
 blanching and dehydration developed at PFR
 - Add value and reduce water and energy use
 - A new large mobile IR unit is built
 - Tests have been conducted with the unit
 - Ready to be shipped to companies for demonstration

CRADA partner: Innovative Foods, Inc., Treasure8 California Energy Commission





Crispy 100% Vegetable and Fruit Snacks Demonstration at Treasure8





Water blanch vs IR blanch Butternut Squash











Solar Drying of Specialty Crops Rebecca Milczarek



 Working with colleagues at the University of California Advanced Solar Technologies Institute (UC Solar) to develop solar thermal solutions appropriate for food drying



ucsolar.org









Innovation

"<u>Never before in history has innovation offered</u> promise of so much to so many in so short a <u>time.</u>"

Bill Gates

