Role of Nitric Oxide in Potato Tuber Wound Healing Processes

Munevver Dogramaci*, Dipayan Sarkar, Edward C. Lulai

United States Department of Agriculture, Agricultural Research Service, Fargo, ND, USA

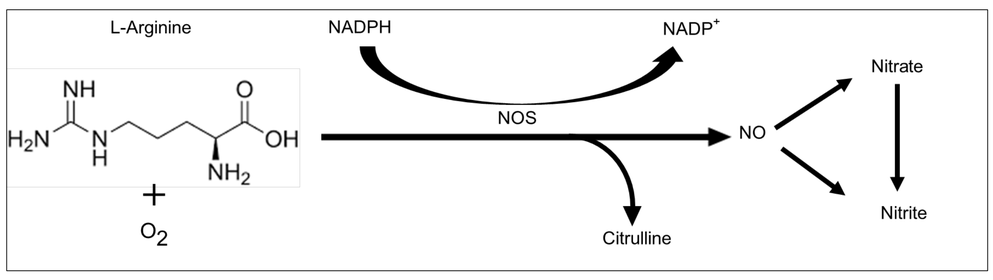
*presenter

Background

- Wounding of potato (*Solanum tuberosum* L.) tubers at and after harvest cause significant economic loss (estimated ≥ $300 million per year) to potato industry
- Wounding or bruising of tubers can occur unintentionally during harvest and postharvest operations, or intentionally during common pre-planting practices of cutting seed tubers before planting
- Rapid wound-healing (WH) is critical for successful long-term storage of potatoes after harvest, and for overall performance of cut seed tuber pieces in the field
- Potato tubers have the natural ability to heal some of the cuts and bruises through formation of protective barrier (suberin layer) on wounded surface
- WH response of potato tubers vary widely among different cultivars as well as based on curing and storage conditions after harvest
- Finding benign strategies to accelerate WH of tubers is critical for the potato industry to minimize wounding associated losses

Nitric Oxide (NO) as a Promising WH Modulator

- NO plays a distinct and modulatory role in WH responses of plant tissues
- Potential utility of NO to enhance healing responses of plant tissues is gaining interest
- NO is synthesized from L-arginine through the activity of nitric oxide synthase (NOS) and nitrate reductase (NR) enzymes



- Modulatory role of NO in potato tuber WH is largely unknown and need to be examined
- External application of NO-related chemicals can be utilized as postharvest treatment to regulate endogenous NO level in wounded tissues and to manipulate WH responses of potato tubers

Objectives

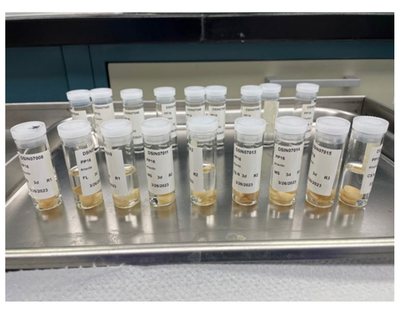
- Determining the modulatory role of NO in WH responses of potato tubers
- Investigating potential impact of NO-related chemical treatments on WH responses of potato tubers

Materials and Methods

- **Potato Tubers:** Certified seed mini tubers of cv. Russet Burbank
- **Wounding Model:** Mechanical wounding of potato tubers to extract tuber discs
- **Chemical Treatments:**
  1. **Control - MES** (2-(N-morpholino) ethanesulfonic acid)
  2. **NO Donor - SNP** (Sodium nitroprusside)
  3. **NO Scavenger - PTIO** (2-phenyl-4,4,5,5-tetramethylimidazoline-1-oxyl-3-oxide)
  4. **NOS Inhibitor - L-NAME** (N^G-nitro-L-arginine methyl ester)

Tuber tissue discs were excised following a wounding model system using a cork-borer

Tuber discs were imbibed in treatment solutions for 1 h and kept on a shaker

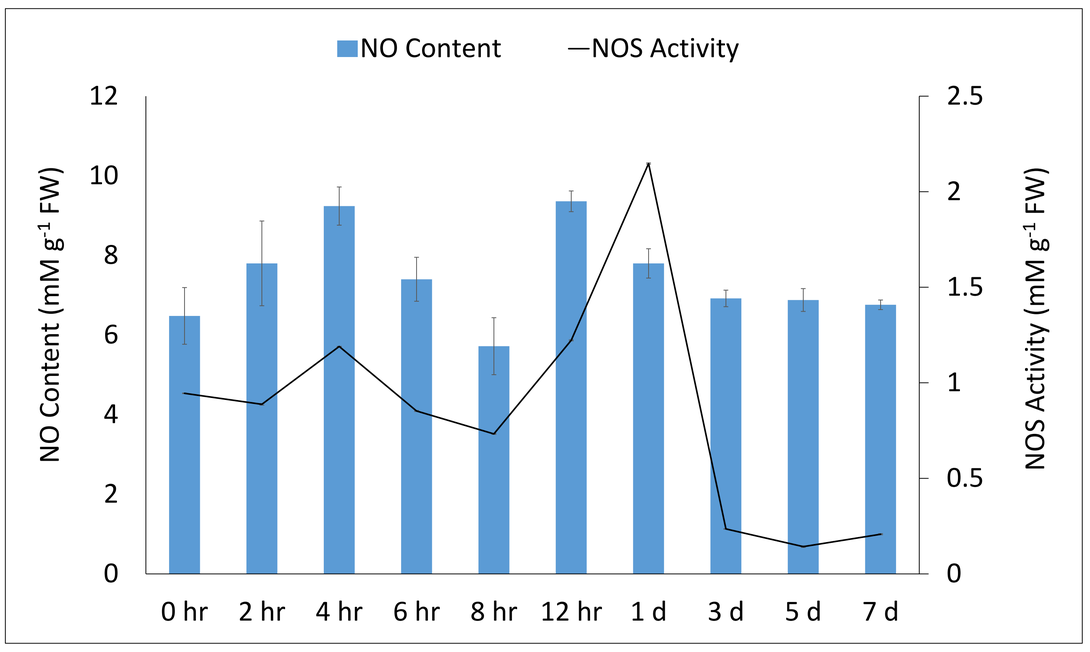


Discs were transferred to a tray and incubated (21°C) to allow healing

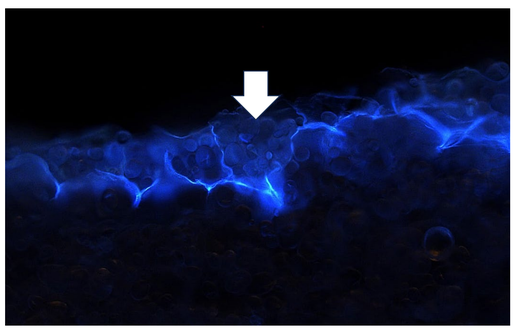
Discs were snap frozen at 0 h and 1, 4, and 8 days after wounding for microscopical and biochemical analysis

Key Findings

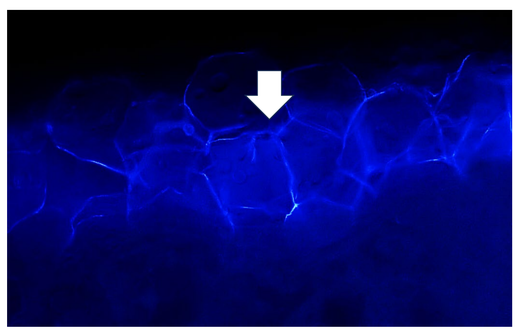
- Increased production of NO and enhanced activity of NOS were quantified immediately after wounding (4h and 12 h) of the potato tuber tissues
- Rapid increase in endogenous NO concentration in wounded tuber tissues indicated a potential role of NO in WH response
- Application of NO donor (SNP) in lower concentration enhanced formation of SPP on wounded cell surfaces while in higher dose it inhibited formation of SPP
- Treatment of NO scavenger and NOS inhibitor in certain doses also enhanced SPP formation in wounded surfaces
- NO-related chemicals impacted SPP formation and can be utilized to manipulate WH responses of potato tubers



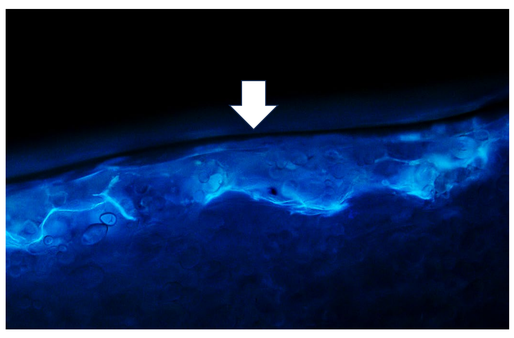
Changes in NO content and activity of NOS enzyme in potato tuber tissues after wounding



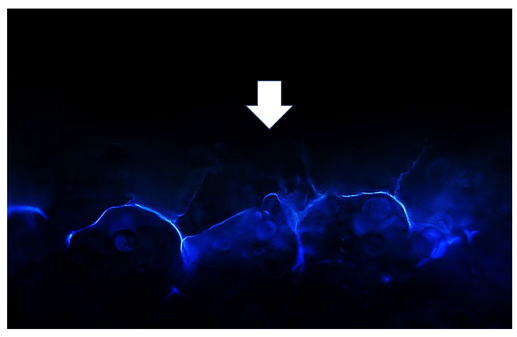
Control- MES **(3.2)**



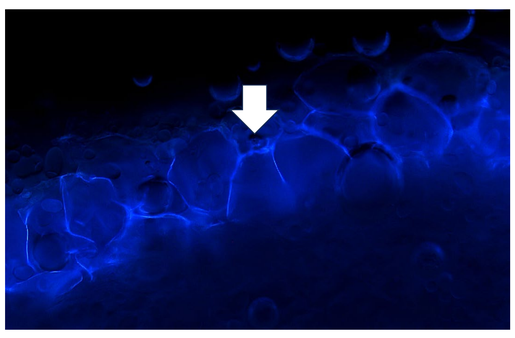
NO Donor- SNP (1mM) **(3.8)**



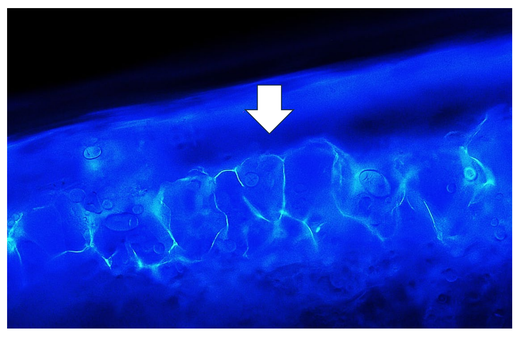
NO Scavenger- PTIO (0.5mM) **(3.5)**



NO Donor-SNP (5mM) **(2.9)**



NO Scavenger- PTIO (1mM) **(3.9)**



NOS Inhibitor-L-NAME (1mM) **(4.1)**

The impact of different NO-related chemical treatments on the formation of SPP at the first cell layer of wounded surfaces after 4 days of wounding; values indicate **suberization rating** based on a standard scale

Future Directions

- Optimization of doses and method of application of NO related chemicals to accelerate WH responses of potato tubers
- Investigating the impact of NO related chemical treatments on other postharvest challenges such as unintended sprouting and diseases of potato tubers

Contact for further information

Munevver Dogramaci, Ph.D.

United States Department of Agriculture
Agricultural Research Service
Sugarbeet and Potato Research Unit
Fargo, ND, USA 58102

Office: 701-239-1257

Work Cell: 701-552-0496

Email: munevver.dogramaci@usda.gov

Better Potatoes for a Better World — PAA — THE POTATO ASSOCIATION OF AMERICA

USDA Agricultural Research Service

POTATO EXPO AUSTIN TEXAS 2024