2004

Title: Improving Value-Added Health Attributes of Colorado Potatoes

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Justification, nature, scope and objectives. Potato tubers (*Solanum tuberosum L.*) provide an important source of high-quality protein and energy to millions world-wide, especially in cool-temperate climates. Less appreciated is the importance of potato as a source of vitamin C, estimated to provide up to 30% of daily intake from fruits and vegetables (Finlay et al., 2003). Potatoes also contain other important nutrients, primarily antioxidants derived from phenolic compounds that have not been well studied from a genetic, production, storage, or cooking heat-stability standpoint.

Data from laboratory screening and analyses of advanced breeding selections conducted in our laboratory during the past three years has shown that considerable potential exists to aid marketing of potato by improving health attributes of new cultivars. Gene expression appears to be the major factor responsible for large differences in potential health attributes. For example, colored flesh genotypes possess 3 to 5Xs antioxidant activity of common cultivars. Similarly, vitamin C content of the highest content selections grown in 2002 was is 4.75xs higher than the standard Russet Burbank. Although far less than genotype, growing location, post-storage reconditioning temperature, and cooking temperature can also impact vitamin C content and radical scavenging activity. Preliminary results from a project that compared eight Colorado cultivars grown at five environmentally diverse production sites strongly suggest that cool temperatures and elevation may enhance antioxidant status of some, but not all cultivars.

It is likely that marketing of potato cultivars might take new directions to meet nutrition conscious consumer demands. Special attributes of new cultivars such as high antioxidant and vitamin C content may provide unique marketing opportunities. Our laboratory is equipped to conduct antioxidant research and can provide screening analyses to assist the breeding program and in efforts to assist the potato industry in developing market identity for potato cultivars with potentially valuable health benefits. We therefore propose to continue research on the following objectives:

(1) Characterize **genetic diversity** of antioxidant content, radical scavenging capacity, and vitamin C for advanced selections and new cultivars.

(2) Examine **production environmental** factors on antioxidant status.

(3) Evaluate **storage/reconditioning** effects on chip antioxidant status.

(4) Evaluate **antioxidant and vitamin C heat stability** with different cooking methods.

Work in progress and plans for 2004

(1) Tubers from 72 **cultivars and selections** grown at San Luis Valley Research Center in 2002 were collected, lyophilized and assayed for total phenolics, ABTS antioxidant radical scavenging capacity and vitamin C. Ninety cultivars and selections have been collected and lyophilized from the 2003 crop. Analysis of the 2003 crop is presently underway and will continue during 2004.

(2) Tubers of eight cultivars and selections (R. Burbank [control], R. Norkotah, R. Nugget, Chipeta, Yukon Gold, CO 94165 [purple], CO 94183 [red]) were obtained from five climatically different Colorado **production environments** in 2002 (San Luis Valley, Weld county, Delta, Arkansas Valley, and Powder Horn). Three locations supplied tubers from the 2003-growing season. These samples are currently being analyzed. Temperature means, extremes and growing degree-day heat units plus precipitation and elevation will be used to interpret climatic effects on antioxidant status.

(3) **Antioxidant status of chips** prepared from tubers reconditioned at 50 and 60 F was determined from 2002 tubers, and will be repeated for tubers grown in 2003.

(4) **Heat stability** of antioxidant status was studied in selected cultivars of the 2002 harvest by comparing uncooked samples to those boiled for 30 minutes, micro waved at full power for 5 minutes/tuber, and baked for one hour at 350 F. Selected Colorado cultivars will be examined again in 2003.

(5) A protocol to quantify **vitamin C** using HPLC was developed this year for 2002 entries. Freeze dried samples of freshly harvested tubers from 72 cultivars have been analyzed. Cooked samples still remain to be analyzed. Tubers grown in 2003 will be analyzed this year.

Tubers for these studies will be obtained mostly from San Luis Valley research test plots and other sites as indicated. Samples will be stored in newly renovated coolers in the Shepardson building, Fort Collins. Lyophilization, spectrophotometric, GC, and HPLC analyses will be conducted in C. Stushnoff's laboratory. All necessary analytical equipment is available, but funds are required for technical labor, service contracts, maintenance, columns, solid phase purification, reagents, gases and micropipette tips.

Relationship of proposed research to the potato industry in Colorado. The work proposed is intended to provide data to assist selection of new cultivars with high antioxidant and vitamin properties for Colorado producers. Our specific role is to seek value-added attributes that focus on human health through dietary intervention. The role of plant-derived antioxidants is receiving increasing attention. While potatoes provide a major source of starch in diets, changing lifestyles and a "carbo-phobic" diet fad threaten growth in consumption. Research data on positive health attributes can assist marketing and consumer confidence. This work provides an opportunity to enhance potentially beneficial attributes of potatoes through plant breeding, and to determine environmental

and storage conditions that can maximize antioxidant and health components of new introductions.

Potential to leverage research funding. We anticipate that opportunities to seek funding in collaboration with the newly established 'Cancer Prevention Laboratory' will be enhanced with data from this work. Results from this work should also enhance opportunities to seek funds from value-added and health related funding programs.

Timeline and expected milestones.

Short term (1 year) expectations.

- Total phenolics, ABTS radical scavenging capacity and vitamin C assays will be completed for 90 entries grown in 2003. A new set of entries will be collected and analyzed from the 2004 harvest. New selections and cultivars will be added annually as an evaluation component of the breeding program. HPLC assays for additional vitamins will be explored.
- Tubers from three distinct environmental production sites for eight cultivars have been prepared for total phenolics and ABTS radical scavenging analyses in 2004. This is the second and final year's data to be collected as part of a PhD project.
- Total phenolics and ABTS analyses will also be run on eight entries in the 2003/2004-storage/reconditioning-chip study.
- Cooking heat stability effects on antioxidant status will be examined for ten cultivars and as many of the 90 genotypes as time and resources permit. We have micro waved, baked and boiled all 90 entries, and will analyze the most important based upon data from the uncooked samples.

Longer term (3-5 year) expectations

- Add new advanced selections and cultivars for genotype analyses and storage studies as they arise from the breeding program. Provide data to aid marketing of new cultivars based upon nutritional properties.
- Complete determination of environmental effects and cooking heat stability on antioxidant status in 2004.
- Develop a screening protocol for additional water-soluble vitamins and apply to advanced selections.

Budget

1. Personnel: Analytical technical support with training to conduct micro plate spectrophotometric antioxidant and HPLC analyses. This could be a postdoctoral associate or hourly research technician, depending on experience and training. It is anticipated that ¾ time equivalent of a postdoc position would be required to conduct all of the proposed work.

Salary (3/4 time)	18,750
Fringe benefits (19.4%)	3,638
Total	22,388/ year

2. Materials and Supplies: reagents, micro plates, tips, and gases. 1,000
3. Travel: local and part expenses for one national research meeting 1,500
4. Equipment (none)
5. Services: Half of service contract for micro plate reader 1,400
6. Total: 30,325

Justification of estimates for personnel costs:

1. Genotype/cultivar assays: 90 entries x triplicate assays x 2 (freeze dried and micro waved) = 540 assays. Maximum of 30 total phenolics and 10 ABTS assays per day including lyophilization, sample preparation, data entry and analyses. Approximately 72, 8-hour days.

2. Vitamin C: HPLC 90 entries x3 =270 assays. Approx. 14 days.

3. Environmental study: 3 sites x eight cultivars x 3 replicates x triplicate assays = 216 assays. Approx. 29 days.

4. Chip reconditioning study: 8 entries x 4 temps x 3 x 3 =288 assays. Approx. 38 days.

5. Cooking heat stability: 10 entries x 4 treatments x 3 =120 assays. Approx 16 days.

The assays are listed in order of priority for available resources.