Nutritional Enhancement of Vitamin B9 in Potatoes: Benefits for the Industry and the Consumer

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Introduction

- Micronutrient malnutrition is a primary global health concern
- Central to this problem is how to provide adequate levels of vitamin B9 (folate) in the diet
- Folate deficiency has been linked to several severe health issues including: neural tube defects, cardiovascular disease, stroke, anemia, certain types of cancer, and impaired cognitive performance
- Developed regions have implemented folic acid fortification programs, but this strategy is not applicable to developing regions
- Even in developed regions, most adults folate intake remains sub-optimal
- Potatoes have been cited as a good source of folate in diets and are grown and consumed in large amounts globally
- Modern potato cultivars only contain around 6% of the recommended daily intake of folate or approximately 400 ng/g dry weight
- Biofortification of staple food crops, specifically potatoes, is a more sustainable long-term strategy to help deliver nutrition to consumers
- This strategy also allows for a unique marketing opportunity for producers and processors

Materials and Methods

- 79 clones from hybridized population (cross between a tuberizing U.S.W.4 and a high folate *S. phureja* accession) plus a Yukon Gold commercial standard were grown in three-hill trials in the HAREC station field and in the HAREC greenhouses in May 2014 and harvested October and November 2014 respectively
- 285 individual plants from 95 accessions and 11 species plus a Russet Burbank commercial standard were grown in OSU main campus greenhouse May 2014, and harvested November 2014
- Three segregating populations, BRR1 (high folate *S. boliviense* 597736 X low folate *S. boliviense* 597736), BRR2 ([high *S. boliviense* 597736 X low *S. chacoense* 320239] X low *S. bolivense* 597736) , and BRR3 (high *S. boliviense* X U.S.W.4 self#3), totaling 144 individuals were planted in OSU main campus greenhouses May 2014 and harvested November 2014
- All tubers were cleaned, photographed, freeze-dried, ground, and prepared for long-term storage between November 2014 and February 2015
- Folate was extracted from all samples via a tri-enzyme reaction and quantified using a microbiological assay as previously described in literature

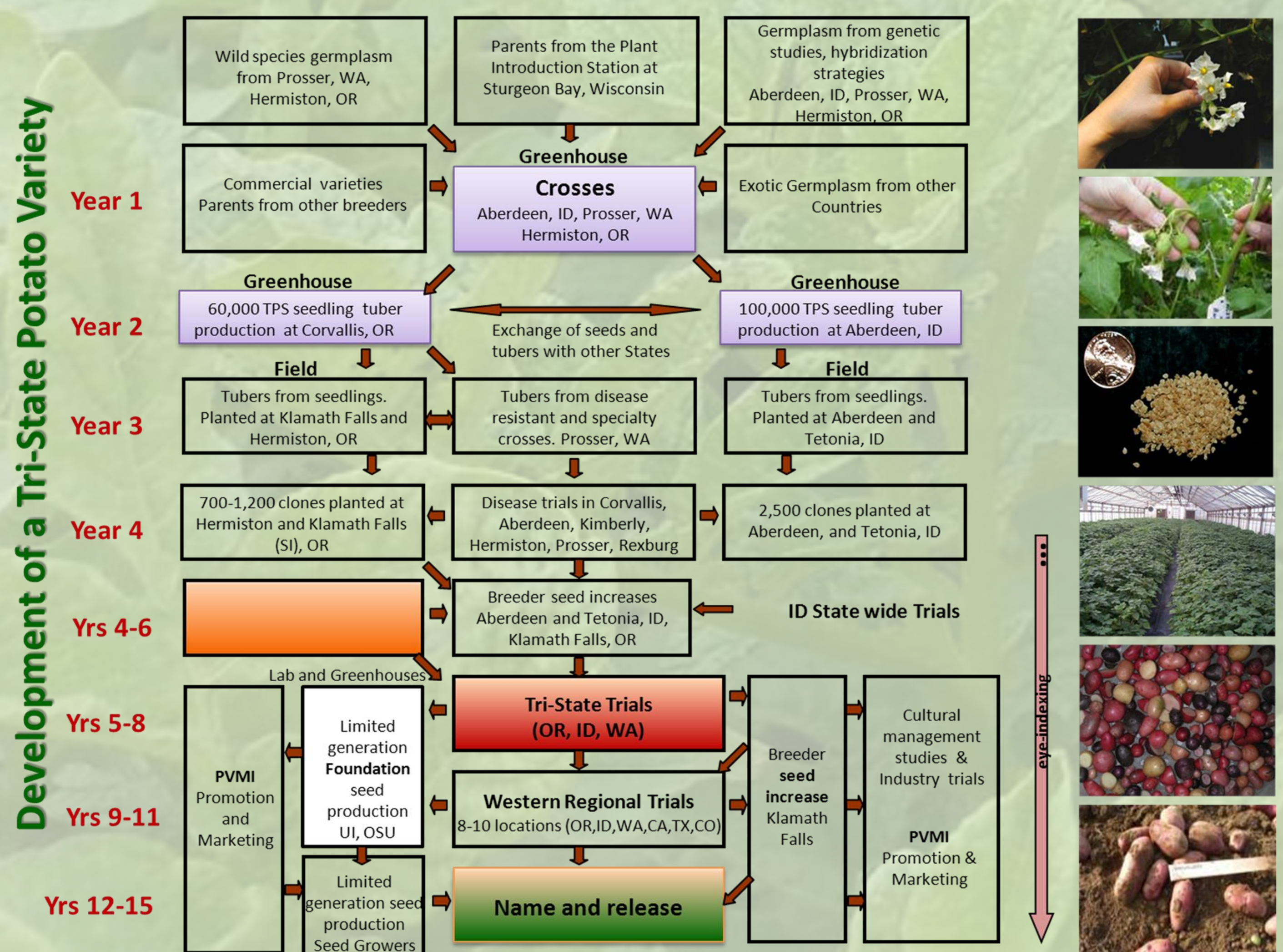

Figure 1. Tri-State plan for potato variety development.

Results

- Hybridized clones from HAREC field trials demonstrated an averaged range of 165 – 1700 ng/g folate and hybridized clones from the HAREC greenhouse demonstrated an averaged range of 235 – 1200 ng/g folate based on dry weight, respectively. Photos of these samples are presented in Figure 2
- Segregating populations demonstrated an averaged range of 470 – 2300 ng/g, 340 – 2150 ng/g, and 300 – 2600 ng/g folate based on dry weight for BRR1, BRR2, and BRR3 respectively. Distribution of folate concentrations in BRR3 population presented in Figure 3
- Wild and primitive cultivated species grown in the OSU main campus greenhouses demonstrated an averaged range of 220 – 2200 ng/g folate based on dry weight (Figure 5 & 6)
- Two of the wild and primitive cultivated species (*S. andigenum* and *S. vernei*) demonstrated consistently higher folate levels when compared to modern cultivars (Figure 6). Photos of these species are presented in Figure 4

Figure 2a and 2b. Visual comparison of the same hybrid genotype grown under different conditions. 2a. HAREC field trial. 2b. HAREC greenhouse trial.

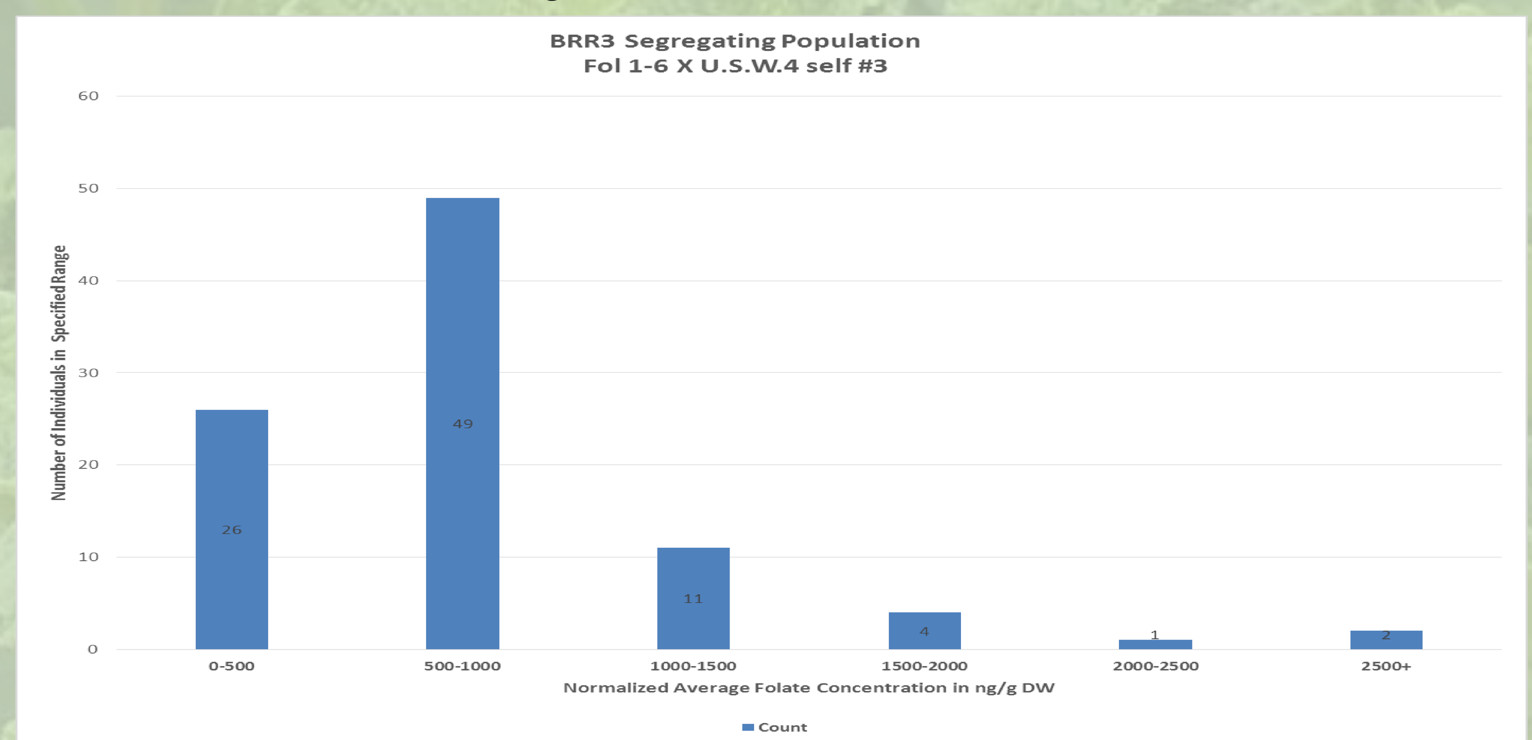

Figure 3. Progeny of a cross for folate segregation. 94 individuals were evaluated for their vitamin B9 (folate) concentration.

Figure 4. The two wild/primitive cultivated species that demonstrated the highest observed folate content were *S. andigenum* (tbr) and *S. vernei* (vrn).

Conclusions

- Evaluation of hybrids, segregating populations, wild, and primitive cultivated species shows that there is a wide range of folate concentrations even though the majority of the materials fall into the lower end of the range
- This shows that there is material demonstrating high folate concentration available for breeding purposes
- Wild and primitive cultivated species show the most promise in terms of genetic ability to produce and accumulate relatively high levels of folate in tubers
- Continued hybridization and evaluation of the heritability of folate content in these materials will be necessary to determine if it is possible to breed for high folate and which species and accessions are the most useful for a significant increase in folate content in modern potato cultivars
- Evaluation of segregating populations indicate that there is segregation for folate content in tubers (Figure 3)
- Further research is currently underway to try and establish molecular markers associated with high folate phenotypes.

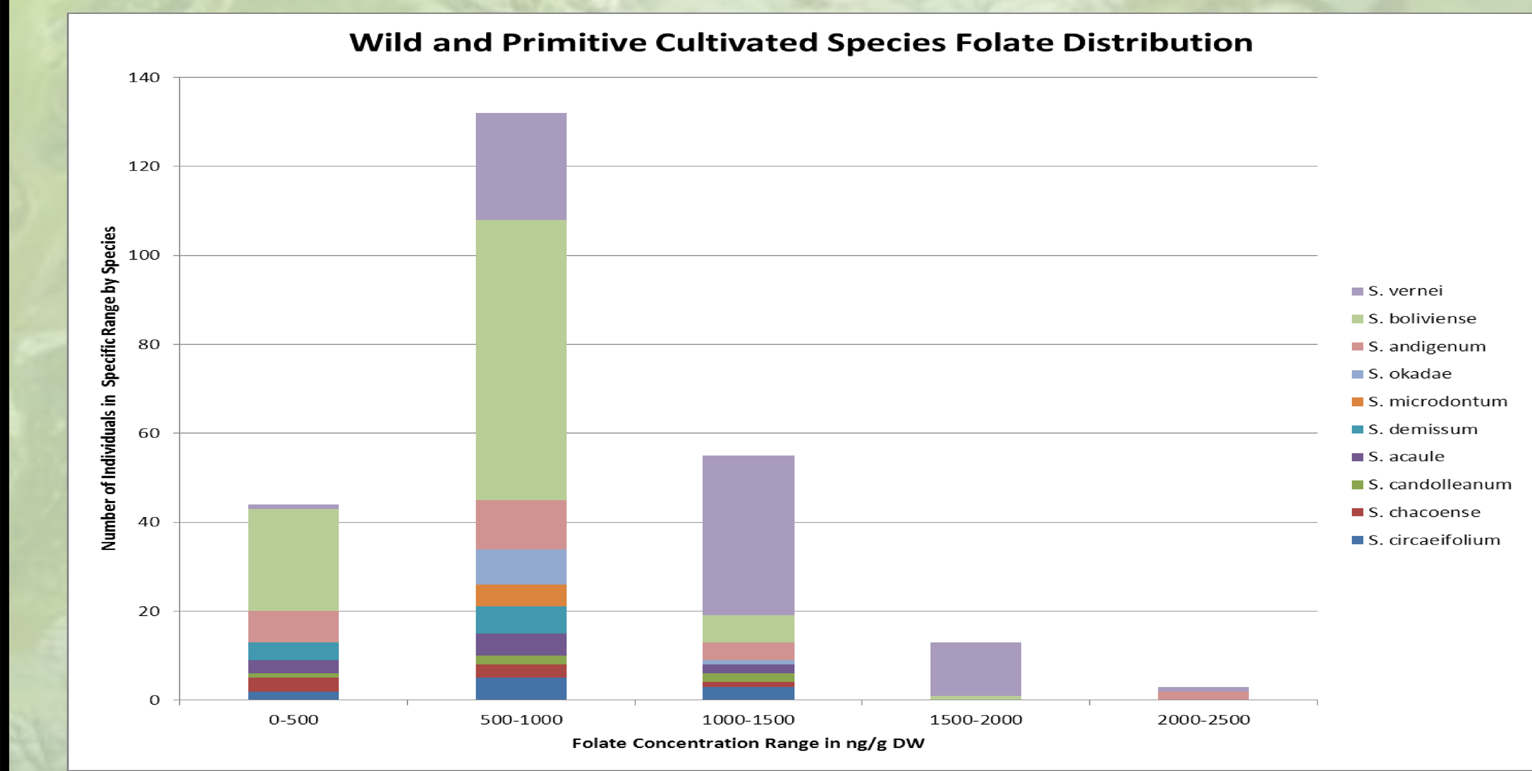

Figure 5. Distribution of folate content among all accessions tested for 10 potato species.

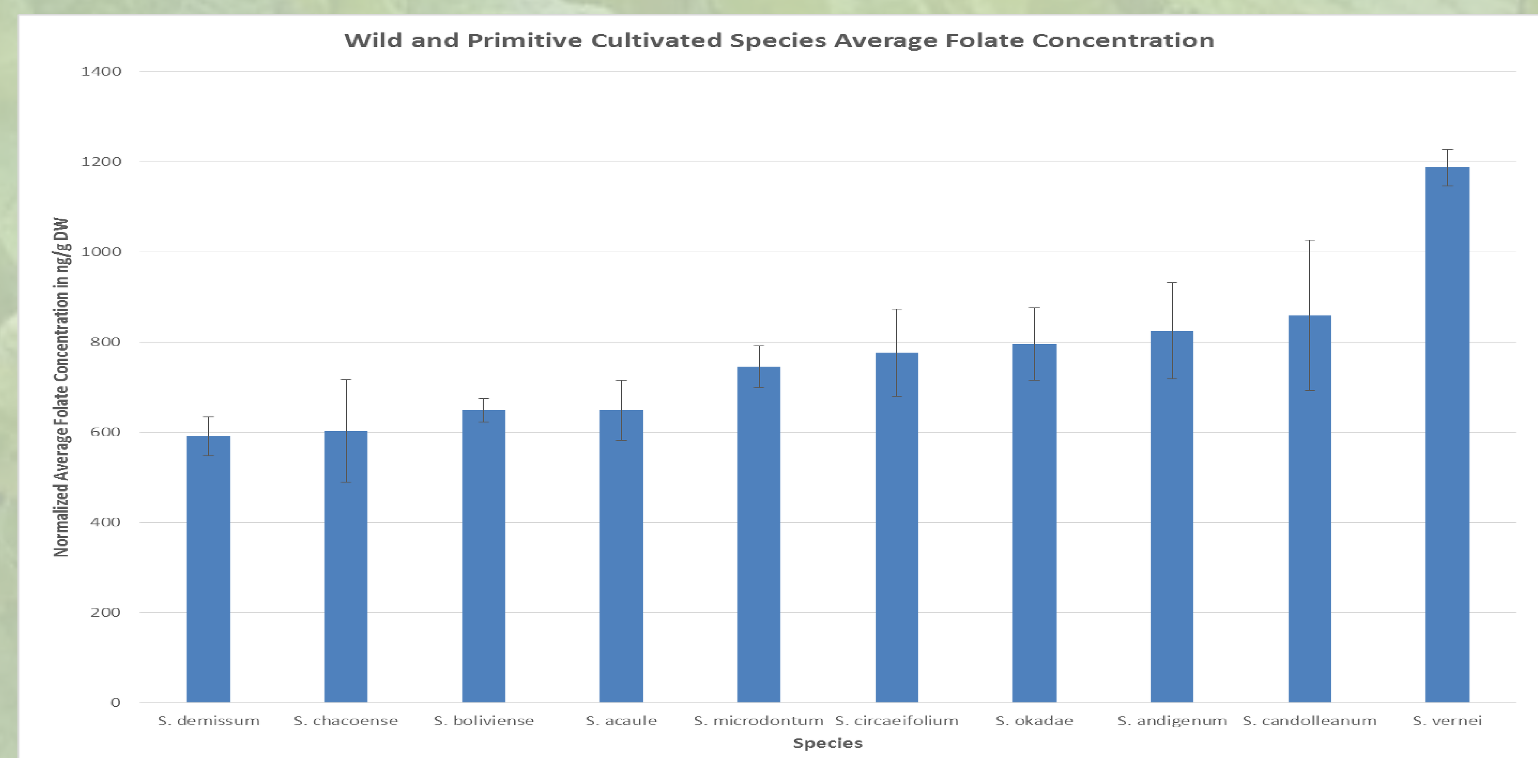

Figure 6. Average folate content of all accessions within 10 potato species.

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