Phenolic Phytochemicals in Fruits and Vegetables are Linked to Health Benefits

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Introduction: It is evident from studies undertaken by the Center for Disease Control and others that diet and obesity-linked chronic diseases and specifically type 2 diabetes are a serious and expensive health-care challenge in America. African Americans and Native Americans are suffering disproportionately and this serious health disparity has to be addressed while advancing food security in these communities.

What would be of special significance is to optimize the amounts of in phenolic antioxidant-type phytochemicals and high fiber in these culture-specific fresh plant food sources since these biochemicals have the potential to inhibit type 2 diabetes-relevant metabolic pathways such as hyperglycemia, hypertension and oxidative stress. The first step is to analyze the type 2 diabetes relevant chronic disease protective fruits, vegetables, legumes, greens, herbs and whole grains that are culturally relevant and produce them locally and then extend this analysis to those commonly grown by other local and regional farmers and those found in the grocery stores. Based on this analysis and health-focused biochemical rationale then encourage at-risk populations to acquire and consume more of the most beneficial foods through community partnerships, innovations for growing locally and clinically validate the design and use of these foods by medical experts.

The above bioactive-specific approach to build fresh plant food systems and associated community partnership for food security with type 2 diabetes relevant food systems is innovative and cost effective. This rationale can be extended to many communities in the US that are challenged by food security and obesity-linked chronic diseases such as type 2 diabetes that are among the highest rates globally. From this foundation of community partnerships and innovations for food security we will also build community partnerships and share experiences for enhancing local food security and health in all communities across the globe.

Scientific Knowledge Gap: The major chronic diseases such as type 2 diabetes and associated complications of hypertension (and linked to cardiovascular diseases) are dysfunctional oxidation-linked diseases, meaning that the oxygen that we need to obtain energy can be deleterious (reactive free radicals) under high calorie diet. Integration of culture-specific and health-focused plant food systems has to be part of advancing food security in various urban and rural communities that are seriously affected by obesity-linked chronic diseases such as type 2 diabetes. Plant foods have a range of phenolic antioxidants (phenolic phytochemicals) that can counter “reactive” oxygen and we have developed an innovative strategy to screen such protective plant foods rich in protective phenolic antioxidants and fiber that can be consistently included in our everyday diet. We have preliminary evidence that traditional diet of Native Americans is rich such protective dietary factors (Kwon et al., 2007b). Further, we have developed *in vitro* assays to screen high phenolic antioxidant profiles to specific type 2 diabetes and hypertension enzyme targets, while at the same time countering the problems of “reactive” oxygen-linked cellular breakdown which has the potential to counter micro-vascular complications of type 2 diabetes such as slow wound healing, macular degeneration and kidney problems. This dietary health protective strategy will also be adapted to screen diverse culture-specific plant foods to be grown locally using an array of *in vitro* enzyme assays as the basis for food design and preparation for rationalizing future clinical studies for primary prevention of the overall disease and management of secondary of complications in partnership with the medical research community.

Current chronic disease drug strategies, though critical and necessary once diagnosis has been made and especially in later stages of disease development, only focus on structure-function breakdown targets (e.g., acarbose for α-glucosidase inhibition but results in high and at times deleterious inhibition of α-amylase). Further they do not prevent breakdown at cellular energy level linked to “reactive” oxygen that leads to many structure-function breakdowns. In contrast the right choice of fresh and whole foods enriched with phenolic phytochemicals as a part of a balanced diet can bring multiple bioactive profiles that can potentially prevent and manage oxidative-linked cellular breakdown moving towards type 2 diabetes and associated micro and macro vascular complications (Figure 1 in pumpkin specific varieties P5 & P6 have the best combination of multiple bioactive factors for potential management of hyperglycemia and overall oxidative stress). Therefore I will be presenting an innovative type 2 diabetes prevention and management strategy for designing and preparing healthy diet from a diversity of culture-specific and locally grown phenolic enriched protective plant foods that have adapted well to our living environment. This is a cost-effective strategy for chronic disease management.

Technology Solution: Using phenolic enriched and disease-focused food designs and preparation, food security and health challenges can be addressed by developing and nurturing effective partnerships between the targeted community and the scientific and medical community to address specific community needs for better health outcomes and reduce health disparity that is so serious in the United States. Based on sound biochemical rationale for healthy fresh food design, food security and health care can be delivered to targeted communities by a variety of community and community-linked technology innovations. Such options include technologies for growing locally in outdoor and indoor environments, community focused food sourcing and distribution centers, building partnerships with scientific and medical community to validate and enhance the use of healthy food systems. These combinations of technology and partnership strategies can be the basis of community food security and reduction of health disparities in terms of chronic diseases such as type 2 diabetes and associated oxidative stress and hypertension-linked complications.

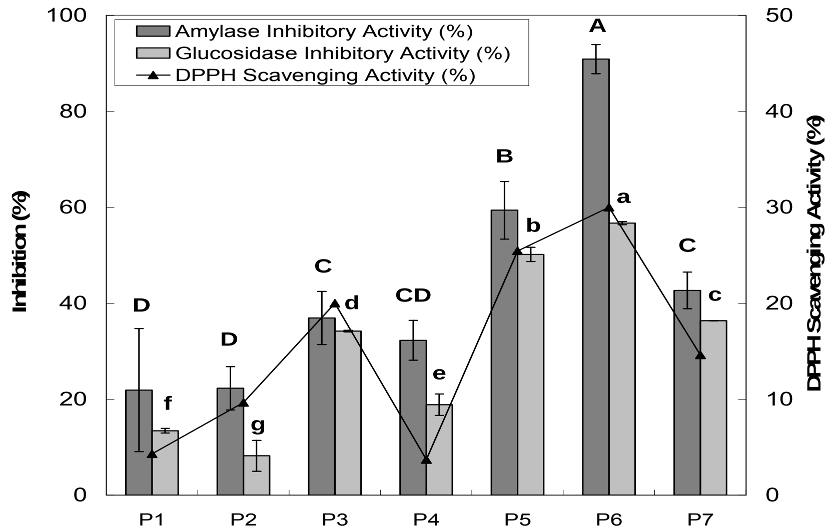

FIG. 1: The comparison of porcine pancreatic α-amylase, rat intestinal α-glucosidase inhibitory activity and free radical scavenging antioxidant activity of autoclaved extracts of pumpkin (Each assay carried out with 200 mg-FW sample/ml concentration. Round yellow: P1, Striped yellow green: P2, Striped round yellow green: P3, Elongated brown: P4, Round orange: P5, Spotted orange green: P6 and Round green: P7).

Preliminary results on select grain and legume sprouts, fruits and vegetables from foods commonly consumed in the United States indicate the presence of phenolic antioxidants (Cheplick et al., 2007; Kwon et al., 2007a; Kwon et al., 2007b; Kwon et al., 2008; Adyanthaya et al., 2009). Correlations between total phenolics, antioxidant activity and functionality have been observed in several cases. This background information could also be the basis of design of whole-food based prepared foods such as soups, cereals, legume-enriched breads and processed vegetables. The understanding of protective functions linked to specific inhibitory pathways linked to countering hyperglycemia, hypertension and oxidative stress by these designed fresh foods or prepared derivates of the same can be targeted to combat type 2 diabetes and there provides a basis for better and culture-specific food design and dietary counter measures.

	Phenolic content (mg/g FW)	Antioxidant Activity %	Alpha-Amylase Inhibition %	Alpha-Glucosidase Inhibition %	ACE Inhibition %
Broccoli	0.57	61	23	19	23
Brussels Sprouts	0.44	45	21	17	17
Cabbage	0.34	47	19	15	19
Cauliflower	0.42	33	14	11	14
Wheat sprouts	1.5	54	35	19	47
Buck wheat sprouts	1.3	45	39	28	65
Corn sprouts	2.2	45	38	30	45
Oats sprouts	0.5	48	47	26	55
Wheat seedlings	1.3	57	45	30	44
Buck wheat seedlings	1.3	47	39	28	58
Corn seedlings	2.7	43	40	27	33
Oats seedlings	0.7	45	55	45	45
Fava Bean sprouts	1.3	51	39	24	51
Mung Bean sprouts	0.42	45	31	17	43
Fenugreek sprouts	0.43	47	57	54	62
Soybean sprouts	0.53	59	52	42	56
Fava Bean seedlings	15.46	49	33	23	63
Mung Bean seedling	5.73	33	18	18	55
Fenugreek seedling	9.42	45	59	39	75
Soybean seedling	1.46	40	42	38	71

References:

Cheplick, S., Kwon, Y-I., Bhowmik, P. and Shetty, K. (2007) Clonal variation in raspberry fruit phenolics and relevance for diabetes and hypertension management. **J. Food Biochemistry,** 31: 656-679.

Kwon, Y.I., Apostolidis, E. and Shetty, K. (2007a) Evaluation of pepper (*Capsicum annuum*) for management of diabetes and hypertension. **J. Food Biochemistry,** 31: 370-385.

Kwon, Y-I., Apostolidis, E., Kim, Y-C. and Shetty, K. (2007b) Health Benefits of Traditional Corn, Beans and Pumpkin; *In Vitro* Studies for Hyperglycemia and Hypertension Management. **J. Medicinal Food,** 10: 266-275.

Kwon, Y-I., Apostolidis, E. and Shetty, K. (2008) *In vitro* studies of eggplant (*Solanum melongena*) phenolics as inhibitors of key enzymes relevant for Type 2 diabetes and hypertension. **Bioresource Technology,** 99: 2981-2988.

Pinto, M.D-S., Ranilla, L.G., Apostolidis, E., Lajolo, F.M., Genovese, M.I. and Shetty, K. (2009). Evaluation of anti-hyperglycemia and anti-hypertension potential of native Peruvian fruits using *in vitro* models. **J. Medicinal Food,** 12: 278-291.