

Bond

2012-2013

Project Title: Development & Commercialization of a “Branded” Colorado Potato- Final Report

Project Summary

Potato producers in Colorado are among the most progressive potato producers in North America and have been very supportive of trialing new potato cultivars in their operations. Currently Colorado producers raise over 100 cultivars annually. A concern that has developed recently deals with minimizing the risk in commercialization of these new cultivars. This project is attempting to determine the correct marketing mechanisms to bring new varieties to market, especially varieties with unique health and/or nutritional attributes. Using consumer research to create a model for commercialization of the four new varieties selected in this project will facilitate the transfer of knowledge about resistant starch levels, higher levels of antioxidants and Vitamin C in these varieties to potential consumers. This information will allow tailored branding of the varieties based on the marketing analysis information derived from this project. The intention is to insure all FDA nutritional guidelines are met to insure the validity of all marketing claims. This project when completed should allow Colorado producers the knowledge to be more competitive in the marketing of new, improved potato cultivars with less risk. This would be a huge step in our strategic goal of promoting the growth of new potato varieties that can be differentiated and branded as “unique to Colorado”.

Project Approach

There are essentially three components of this project; the agricultural production and best management practices of the four potato varieties, the nutritional assay of the health attributes within the four varieties, and the consumer and marketing research necessary to understand how these varieties can be best be branded and marketed. Each of these components was met with varying degrees of success which are outlined below in the next section.

Goals and Outcomes Achieved

1. Agricultural Production and Best Management Practices (BMP)

The table below summarizes the various timelines for the project.

Production and BMP's	Timeline	Status
Identify the cultivars	2009-2010	Completed, 4 varieties identified
Develop acreage for production	Summer of 2010	Seed production completed, commercial production being identified for 2012
Develop production strategies	Production season 2010-2011-2012	Ongoing- Currently analyzing harvest results and field notes to develop cultural BMP's
Develop Post Harvest strategies	Storage season 2011-2012	Ongoing- Plot samples undergoing storage testing

Identifying cultivars and meeting the seed supply needs for the project

The four varieties utilized for this project were: Rio Grande Russet, Purple Majesty, Crestone Russet (CO99053-3RU), and Masquerade (AC99329-7PW/Y). Each of these varieties was selected for unique characteristics that make them appropriate for the project.

The cultivars identified which fit the specific parameters of this project, each with a unique combination of traits for the marketplace. Rio Grande Russet is a very smooth, high yielding russet with low inputs like water and Nitrogen and excellent flavor and high levels of antioxidants. Crestone Russet is another very smooth, medium to late maturing russet with low inputs, high yields and excellent flavor. Additionally, it has some significant disease resistance to certain problems including powdery scab and *Fusarium* dry rot. Purple Majesty is the first really good tasting purple skin, purple flesh cultivar to make it to the market. It has exceptional health attributes, fits well into the specialty market and has a very smooth, consistent tuber type with excellent yields and few disease issues. Finally, Masquerade is a bi-color skin (purple/yellow) with yellow flesh. It has great production potential with excellent yields of medium sized tubers, is very pretty, striking in appearance, and has phenomenal flavor and health attributes. Its only disadvantage is the rapid germination of the tubers when removed from storage due to a very short dormancy.

Seed acreage was developed at the SLV Research Center for each of the cultivars to meet the requirements for part of the grant. In 2012 there were 10.2 acres of Rio Grande Russet (G1-G4), 7.4 acres of Crestone Russet (G1 and G3), 2.0 acres of Purple Majesty (G1-G3) and 1.4 acres of Masquerade (G1-G3) providing a stable seed supply for interested potato growers in Colorado. Producers in the certified seed program have begun to adopt these cultivars as part of their routine growing operation as seen in Table 1.

Table 1. Cultivar acreage by year in the Colorado seed potato certification program.

Cultivar	2009	2010	2011	2012
Rio Grande Russet	1758	1252	1284	1171
Crestone Russet	3	3	10	64
Purple Majesty	67	85	143	177
Masquerade	0.1	0.1	1	8

Nutrient Management (Samuel Essah)

Nutrients being evaluated include nitrogen, phosphorus, potassium, and compost rate, along with nitrogen and calcium application timing. Weekly petiole samples were analyzed for nitrogen, phosphorus, and potassium. This data was used to establish optimum petiole nutrient concentration levels to achieve maximum yield and quality goals in production.

The last two years field studies were laid down as a randomized complete block design. Each treatment was replicated four times. Treatments included nitrogen application rates at 60, 120, and 180 lb N/ac. A control treatment was included where no nitrogen fertilizer was applied. During the spring of each year, soil samples were taken from the experimental site and analyzed for residual soil nitrate nitrogen (N). Water samples were taken from the irrigation well and analyzed for nitrate nitrogen concentration. The residual soil N and irrigation water N added up to 28, 68, 61, and 80 lb N/ac, for Rio Grande Russet, Crestone Russet, Purple Majesty, and Masquerade, respectively. Knowledge of the residual soil and irrigation water N is important to help estimate how much nitrogen fertilizer is needed to apply for maximum tuber yield and quality.

Plant Population and Density

Tubers were sampled weekly after tuber initiation to determine bulking rates. The harvested plots were graded and sized. The objective of these studies was to evaluate the optimum plant population needed for maximum tuber yield and quality of four Colorado cultivars. Plant

population varied depending on the in-row seed spacing treatment. Seed spacing treatments included planting potato seed tubers at 10, 12, and 14 inches.

The field studies were laid out as randomized complete block design. Each treatment was replicated four times. Specific gravity testing from plot samples was conducted in December.

The following is a list of the specific production guidelines for each of the four cultivars:

1. Rio Grande Russet:

Available Nitrogen (residual soil N + well water N + applied N) rate required for maximum tuber yield and quality was observed to be between 150 to 160 lb N/ac. With a soil test of 264 ppm potassium (K) in the spring, maximum total and marketable tuber yields could be achieved when 120 lb K₂O/ac is applied. The use of potassium sulfate as source of K fertilizer is preferred to muriate of potash, because potassium sulfate tends to increase marketable tuber yield and also help increase tuber specific gravity. To obtain maximum marketable size tubers, seed tubers should be planted at in-row spacing of 12 inches, with row spacing of 34 inches. To gain early plant vigor, apply 90 lbs available N/a pre-plant or at planting. Apply the remaining N requirement in three split applications at approximately 7 days interval. Start in-season N application at tuber initiation. Vines should be killed at 110 days after planting to allow tubers to mature and to avoid tuber bruising at harvest. Pre-cut seed to a size of 2.5 to 3.0 oz. and allow it to suberize before planting.

2. Crestone Russet:

Available nitrogen needed for maximum tuber yield and quality of Crestone Russet should be between 120 to 140 lb N/ac. Increasing the available N rate above 140 lb N/ac. can reduce tuber specific gravity and increase the production of more tuber misshapes. In-season petiole nitrate nitrogen concentration should range from 12000 ppm at 67 days after planting (DAP) down to 5000 ppm at 88 DAP. To obtain maximum marketable tuber yield with reduced seed input, Crestone Russet should be planted at in-row spacing 13 to 14 inches, with row spacing of 34 inches. Pre-cut seed to a size of 2.5 to 3.0 oz. and allow it to suberize before planting.

3. Purple Majesty:

Available nitrogen rate required for optimum production of purple majesty was observed to be between 140 to 150 lb available N/ac. When available N is within the 140 to 150 lb/ac. range, there is an increase in marketable tuber yield, reduced tuber external and internal defects, and an increase in Nitrogen Use Efficiency. For in-season N management, petiole nitrate N concentration should range from 4000 ppm at 70 DAP down to 3000 ppm at 84 DAP. Calcium can be applied at a rate of 30 lb/ac in two split applications during tuber formation to increase tuber yield. Seed piece should be planted at in-row spacing of 13 to 14 inches to obtain maximum tuber size. Vines should be killed between 100 and 105 DAP to allow tubers to mature, and for tubers to develop high specific gravities.

4. Masquerade:

Masquerade responds to high nitrogen application rate. For maximum tuber yield, available N rate should range between 210 to 220 lb/ac. For in-season nitrogen management, petiole nitrate N concentration should range from 8000 ppm at 60 DAP to 19000 ppm at 75 DAP. Seed tuber should be planted at 14 inches within rows, with row spacing of 34 inches, to achieve high yields of marketable size tubers.

Disease Resistance (Robert Davidson)

All variety plots were inspected weekly and screened for diseases during the growing season. No major problems were noted.

Each of the four cultivars show differing levels of susceptibility to common disease problems found in the San Luis Valley (Table 2), but all have relatively good levels of disease resistance and/or tolerance and few major problems have been seen under field growth. It is of note that each of the cultivars has been repeatedly screened for several years and under very different environmental conditions with few problems demonstrated.

Table 2. Ranking of major disease issues by cultivar

Disease	Rio Grande Russet	Crestone Russet	Purple Majesty	Masquerade
BRR ¹	9	8	9	8
PLRV	5	7	5	4
PVY	6	7	5	4
Powdery Scab	2	1	5	5
Pink Rot	4	4	7	4
Soft Rot	7	4	7	4
Dry Rot	4	5	4	5

¹Rankings for disease are from 1-10 with 1-3 resistant, 3-4 moderately resistant, 5-6 moderately susceptible and 7-10 susceptible. BRR - bacterial ring rot, PLRV - potato leaf roll virus and PVY - potato virus Y.

Results of this work have been communicated to producers raising these cultivars on a one-on-one basis and during the Southern Rocky Mt. Ag Conference over the last two years.

Two abstracts were submitted to the annual PAA meeting in 2012 and presentations made during the conference; "Cultivar improvements for powdery scab resistance in the Colorado Cultivar Development program" and "Evaluation of potato cultivars in a greenhouse for determining potential to reduce powdery scab inoculum levels in soil".

Post-Harvest/Storage Management (Sastry Jayanty)

After harvest plot samples were tested using different storage regimes. Information gathered from 2010 and 2011 storage testing was incorporated into 2012 testing. One problem encountered in the storage results was discovering that Masquerade has a very limited natural dormancy and will require special care in storage handling to insure an extended marketability window. If they are stored at 38°F (3.3°C) with 95% relative humidity, they can maintain four to six months without sprouts. But after leaving storage they quickly develop sprouts at room temperature within days. Four different sprout inhibitors were tested (two organic and two conventional) to extend dormancy in these two cultivars after removing from long-term commercial storage. Conventional sprout inhibitors such as CIPC have proven more effective than of all other sprout inhibitors available. The organic sprout inhibitor L-Carvon was more effective than clove oil in reducing sprouting in Masquerade and Purple Majesty for 30 days in 2010 testing. During the 2011-2012 storage season we tested both organic and conventional inhibitors at three different temperature regimes and multiple application timings to extend dormancy.

The results when the efficacy of sprout inhibitor treatments were tested to increase storage time follow. The conventional and organic sprout inhibitors tested included: Clove Oil, EC-40, EC-15, CIPC with DMN (CIPC2), DMN alone, and CIPC alone. Organic treatments include Clove Oil, EC-40 and EC-15. CIPC with DMN, DMN alone, and CIPC alone are conventional treatments. We tested these compounds at three different storage temperatures 38 °F (3.3°C), 45 °F (7.2 °C) and 50°F (10°C). We measured shrinkage, sprout length and sprout weight for all the cultivars advanced selections tested after 3 months of storage. Organic sprout inhibitors were applied again after observing sprout initiation during storage period to extend dormancy and to study their efficacy in sprout inhibition. (EC-40, EC-15 - Biox sprout inhibitors (Pace International); DMN 1,4 ethyl naphthalene; Dimethyl naphthalic; CIPC chlorpropham). All sprout inhibitors were applied based on manufacturers dosage and rate recommendations

Highlights

- Masquerade and Purple Majesty, when treated with sprout inhibitor EC-15 and maintained at 38°F, lost less weight than untreated controls.
- CIPC treated tubers had no significant sprouting at any temperature and tubers lost more weight as temperature increased.
- Masquerade lost the least weight at 38°F when treated with EC-15 and Clove Oil and had no sprouting in either. Conventional sprout inhibitors such as CIPC2 and CIPC allowed minimum sprouting even at 50°F during initial 3 months.
- At 38°F Purple Majesty lost the least weight with EC-40 and CIPC2 and had no sprouting in either temperature. Purple Majesty had minimum sprouting at 50°F with CIPC2 and CIPC; and lost the least amount of weight with CIPC2.
- DMN is not an effective sprout inhibitor even at 38°F storage temperature.

2. Nutritional and Health Attributes (Sastry Jayanty and David Holm)

One of the goals for this element of the project is to determine FDA requirements for the nutritional claims we are hoping to use and the steps in the approval process. Specific testing has been done to analyze the nutritional attributes of the four selected varieties. This testing is ongoing and needs to verify the necessary FDA requirements. Dr. Jayanty presented the some of the results of his experimental testing to the Potato Association of America on August 15th, 2011 in Wilmington, North Carolina.

During the course of the project nutritional and health attributes of the four selected cultivars and advanced selections were characterized. This information was generated based on the tests that include estimation of resistant starch levels, antioxidant activities, nutritional composition analysis and flavor. The idea is to present the consumer with improved dietary health attributes of these cultivars for brand identification and to increase sales and profitability. This matches the information needed by the consumers based on survey data gathered during the project. As consumers develop a better awareness of health attributes, it is to be expected that they would start to use this information in developing buying choices for potatoes.

Table 3

Resistant starch

Potatoes are rich in carbohydrates and are also a good source of minerals and vitamins. However, recent evidence linking the glycemic index (GI) of foods to risk for a number of chronic diseases and the general perception that potatoes have a high GI, have raised concerns about the health benefits of potatoes. Starch rich foods, such as potatoes, when consumed are metabolized to the monosaccharide glucose, which then enters into

Blood stream causing a temporary rise in blood glucose levels.

This "glycemic response" is measured as the GI. Resistant starch (RS), which as a low GI and alpha amylase inhibitors (AAI) are believed to reduce a food's GI. Leaves and tubers were harvested from different cultivars grown in Colorado and advanced selections being developed at the SLVRC for estimation of AAI and RS. The data indicate that there is significant variability in potato selections and cultivars for both RS and AAI (Table 3)

Cultivars	Total starch (g/100 g potato material)	RS (g/100g total starch)		NRS (g/100g total starch)
		RS – Raw	RS-Baked	
Dark Purple Flesh	63.37	12.06	4.76	95.45
Purple Majesty	70.46	13.43	3.24	96.86
Yukon Gold	60.10	34.64	2.32	97.73
Rio Grande Russet	59.84	23.71	9.70	91.16
Rio Colorado	63.32	17.98	3.73	96.40
Mountain Rose	62.16	12.15	6.71	93.72
Lenape	63.90	14.52	6.14	94.22
CO94035-15RU	68.49	20.27	5.33	94.94
CO95051-7W	71.81	32.86	5.72	94.59
AC96052-1RU	66.37	14.62	10.38	90.60
CO97226-2R/R	60.48	9.81	8.77	91.93
CO97232-1R/Y	66.00	23.78	5.49	94.80
AC97521-1R/Y	61.02	23.76	7.07	93.39

Antioxidant levels and effect of cooking on them in different cultivars

Potato tubers, which are one of the richest sources of antioxidants, are always cooked before human consumption. The objective of this study was to understand the effects of various domestic cooking methods, i.e., boiling, microwaving and baking on total phenolics, flavonoids, flavonols, lutein, anthocyanins and antioxidant activities in 5 cultivars and 9 advanced selections with different skin and flesh colors after 6 months of storage. The three cooking methods reduced the levels of these compounds and the percentage of DPPH (2,2-Diphenyl-1-picrylhydrazyl) radical scavenging activity in all the cultivars and selections. Boiling minimized these losses. Red fleshed tubers contained more flavonoids, whereas purple tubers contained more flavonols. Despite severe loss of these compounds due to cooking, both the flesh types retained larger amounts of all these compounds due to higher initial levels. Decline in the radical scavenging activity is directly related to loss of these compounds due to cooking treatments in all white and colored flesh tubers. Red and purple fleshed tubers exhibited greater radical scavenging activity than yellow and white fleshed tubers after

Nutritional value	Cooking method		
	Boiled	Microwaved	Baked
Total phenols	↓	↓↓	↓↓
Total flavonoids	↓	↓↓	↓↓
Total flavonols	↓	↓↓	↓↓↓
Lutein	↓	↓↓	↓↓
Pelargonidin	↓	↓↓	↓↓
Delphinidin	↓	↓↓	↓↓
Malvidin	↓	↓↓	↓↓
Antioxidant activity	↓	↓↓	↓↓↓

each of the cooking treatments. Table 4 has the summary of nutritional values of potato cultivars and advanced selections affected by cooking methods. The number of inverted arrows indicate the degree of loss of nutritional value.

Selenium levels in Colorado cultivars

Selenium (Se) is an essential trace element in the human body. Development and survival of animals and humans will be at risk without Se. Higher levels of Se in blood plasma have been correlated with reducing many cancers. Potato plants are being supplemented with selenium (Se) in several countries to enrich tubers with Se for obvious health benefits. Se is not an essential nutrient and interferes with metabolism of essential nutrient sulfur (S) in the plants. The objective of the present investigation was to find out the activities of Se-independent glutathione peroxidase (Se-Ind-GPx), Se-dependent glutathione peroxidase (Se-Dep-GPx), and thioredoxinreductase (TRxR) enzymes in stored potato tubers grown on non-Se-enriched field; and their relationship with tuber Se and S levels. Our results indicate that these enzyme activities and the nutrient levels in the tubers were significantly influenced by genotype. Tubers of Rio Grande Russet, Crestone Russet, and Purple Majesty can supply more than the recommended dietary allowance (RDA) of Se to adult humans.

Furthermore, Se-Dep-GPx activities were influenced by Se levels in the tubers.

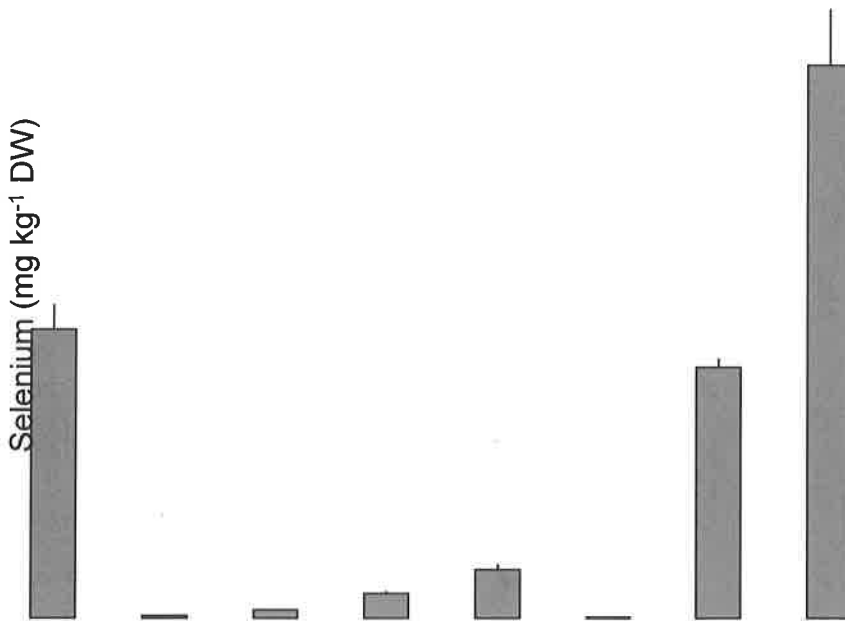


Figure 1

Volatile compound analysis in Colorado potato cultivars and advanced selections using solid phase micro extraction technique

We tested three cooking methods, (i.e., boiling, microwaving and baking) on six month old stored tubers. Six to eight randomly selected tubers from each potato cultivar or advanced selection of Rio Grande Russet, Purple Majesty, Crestone Russet and Masquerade were tested using Solid Phase Micro Extraction (SPME) and Gas Chromatograph and Mass Spectrometry (GCMS). We quantified 10 different flavor volatiles in three different cooking methods. Our results indicate cultivars differ in volatile profiles and cooking treatment affects volatile

concentrations. Different cooking methods affect volatile compounds in a different way. Furfural which brings sweet and nutty flavor completely disappeared in the baking process. Pungent, Sweet and Fruity flavor compound, 3methyl butanal is higher in Purple Majesty and Masquerade. Alpha coapene which is a dominant potato flavor compound is present in all cultivars tested except Crestone Russet. Limonene and carene are major terpenes in the volatiles of Crestone Russet.

Highlights

- After baking Rio Grande Russet retained a considerable amount of resistant starch
- Polyphenols and pigments in potato were reduced by boiling, microwaving and baking.
- Antioxidant activity of the tubers was decreased by cooking methods.
- Red and purple tubers retained higher antioxidant levels after cooking methods.
- Loss of polyphenols and pigments were low in boiling and severe in baking.
- Selenium is very important dietary supplement
- Tubers of Rio Grande Russet, Crestone Russet, and Purple Majesty can supply more than the recommended dietary allowance (RDA) of Se to adult humans
- Out of 4 cultivars and advanced selections tested, Purple Majesty and Masquerade exhibited more flavor compounds when analyzed using GC-MS after steaming, microwaving and baking.

Publications:

Venu Perla, David G. Holm and Sastry S. Jayanty* (2012). Effects of cooking methods on polyphenols, pigments and antioxidant activity in potato tubers. *LWT- Food Science and Technology* 45:161-171.

Venu Perla and Sastry S. Jayanty* (2012). Biguanide related compounds in traditional antidiabetic functional plant foods. *Food Chemistry*

Venu Perla, David G. Holm and Sastry S. Jayanty* (2012). Selenium and sulfur content and activity of associated enzymes in selected potato germplasm. 2012. *American Journal of Potato Research*. 89:111-120.

New Variety Identification and Development (David Holm)

The overall goal of this project as stated in the title is in keeping with the mission statement of Colorado Potato Breeding and Selection Program (Program), i.e. to develop cultivars that will help assure that the Colorado potato industry remains productive, competitive, and sustainable and to develop cultivars that provide the consumer with improved nutrition and quality.

Therefore it is appropriate that four selections from the Program were used for this project. They were individually identified because of characteristics (nutritional, taste, dietary, and appearance) that would make them good subjects for a branding study.

The process of developing a new cultivar takes 14+ years. Years 1 and 2 are the potato breeding phase of the development process. Parents are selected with desired characteristics and crossed to produce true (botanical) potato seed (TPS). Seedling tubers are then produced from the true seed in year 2. Subsequent years (3+) represent the selection phase of the development process. Each year represents another cycle of field selection. As each cycle is completed, fewer and fewer clones remain and the amount of seed per selection is increased. Throughout the evaluation process selections are tested for characteristics of importance. Some of these characteristics are associated with consumer acceptance and recognition in the marketplace.

Each year the Program identifies selections that merit advanced testing associated with characteristics that are amenable to branding. These new cultivars are identified which have improved nutritional aspects and quality that lend themselves well to differentiation and branding. For this project, eighty-five advanced selections were planted in 2012 and will be increased in 2013 pending results of ongoing evaluations. Advanced selections evaluated in the Southwest Regional Trials, Western Regional Trials, or by Colorado producers in 2012, included 11 russets (AC99375-1RU, AC00395-2RU, CO99053-3RU, CO99100-1RU, CO03187-1RU, CO03202-1RU, CO03276-4RU, CO03276-5RU, CO04211-4RU, CO04220-7RU, and CO04233-1RU), 5 reds (CO99076-6R, CO99256-2R, CO00277-2R, CO00291-5R, and CO04159-1R), 11 chippers (AC00206-2W, AC01151-5W, AC03433-1W, AC03452-2W, CO00188-4W, CO00197-3W, CO00270-7W, CO02024-9W, CO02033-1W, CO02321-4W, and CO03243-3W), and 17 specialties (AC99329-7PW/Y, AC99330-1P/Y, AC03534-2R/Y, ATC00293-1W/Y, CO97222-1R/R, CO97226-2R/R, CO97232-2R/Y, CO00412-5W/Y, CO01399-10P/Y, CO04021-2R/Y, CO04029-5W/Y, CO04013-1W/Y, CO04063-4R/R, CO04067-8R/Y, CO04099-3W/Y, CO04099-4W/Y, and CO04188-4R/Y).

Publications:

Madiwale, Gaurav P., Reddivari, Lavanya, Holm, David G., and Vanamala, Jairam. 2011. Storage elevates phenolic content and antioxidant activity but suppresses antiproliferative and pro-apoptotic properties of colored-flesh potatoes against human colon cancer cell lines. *J. Agric. Food Chem.* 59:8155–8166.

Madiwale, Gaurav P., Reddivari, Lavanya, Stone, Martha, Holm, David G., and Vanamala, Jairam. 2012. Combined effects of storage and processing on the bioactive compounds and pro-apoptotic properties of color-fleshed potatoes in human colon cancer cells. *J. Agric. Food Chem*

3. Marketing and consumer research program (Jennifer Keeling-Bond)

The table below summarizes the consumer and marketing research element of the project:

Consumer and Marketing Research	Timeline	Status
Assessing consumer knowledge of potato nutrition	2009-2010	Completed- important consumer knowledge identified
“Brand” creation	2010-2011	Completed- specific labels designed and tested for varieties
Sensory analysis report	2010-2011	Completed- Consumer taste preferences identified
Analyze research data for information gaps	2011-2012	Ongoing- Further analysis of the data
Marketing strategy development	2012	Beginning in 2012

The marketing research under the direction of Dr. Jennifer Bond focused on assessing consumer knowledge of potato nutrition and health characteristics possessed by potatoes. The primary methods for this involved sensory analysis, label creation, secondary data review, and development of choice set survey and consumer experiment protocols. Three Colorado State University faculty members and one graduate student are assisting with this project.

Sensory analysis

Testing was conducted in mid-July of 2009. Statistical analysis of the in-home and trained panels was completed in 2010 and a draft of the keys findings has been completed.

Label creation

Sample labels were created by Alysce Christian and submitted to the marketing team for feedback. This feedback was instrumental in creating the final label design. The labels are appropriate for use on both poly-bags and clam-shell type packaging. Application of label claims will now be determined through analysis of the collected consumer data. Data gathered in pre- and post-revelation on nutrition information testing determined that consumers were willing to pay more after being exposed to the nutrition information. This information will be valuable in determining label information.

Sample Label



Secondary Data Review

A review has been completed of national consumption trends and a published report has been completed. Further analysis of this data was conducted in early 2011 along with the consumer experiment research to determine which health attributes have the greatest value to consumers. The data revealed that consumers were “Least Knowledgeable” about resistant starch content (44%) followed by antioxidant levels (31%). Discovering baseline consumer nutrition levels are important in developing marketing strategy moving forward.

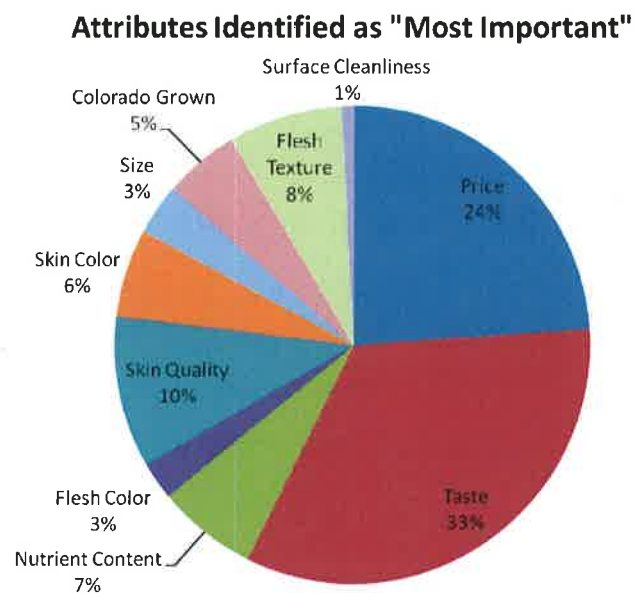
Choice Set Survey and Consumer Experiments

After developing experimental protocols the actual experiments were conducted in October and November 2009, and June of 2011. The actual experiments consisted of a consumer demand survey and analysis of willingness to pay for various combinations of label claims and product attributes. This was followed up with practice auctions, and actual potato auctions. Following the auctions sensory evaluation using the four potato varieties was conducted on both baked and microwave potatoes. Each experiment took between 1.5-2 hours and six actual experiments were conducted with over 140 volunteer subjects. Key consumer preferences have been identified through this research. The graph below illustrates consumers “most important” potato attribute preference.

Key points developed from the consumer surveys include:

- Taste is the most important attribute by a factor of 2.5 – 5 over price and other physical attributes that affect mouth feel and enjoyment
- Nutrient content, source, and convenience are ranked last
- Significant heterogeneity – positive correlations between nutrient content and source

- Consumers are most knowledgeable about preparation methods and price, but least knowledgeable about nutrition information
- Consumers self-report most knowledge about preparation (by a factor of 2-7) over price
- Report very little knowledge regarding nutritional information, caloric content, and source
- Negative correlations between knowledge about price and vitamin and mineral content
- There is a negative relationship between knowledge about nutrition and knowledge about price
- Consumers view Taste and related attributes (skin quality, flesh texture, and color), along with price, as most important when purchasing fresh potatoes,
- Consumers in our study did view nutrition, source, or convenience as very important
- Bottom line: Taste and related attributes dominate others in importance, and very little is known about potato nutrition qualities



Additional marketing efforts around Colorado (Robert Davidson)

The cultivars used in this project were distributed to several private growers in Colorado over the past three years for use as garden seed and for sale in commercial operations. Overall satisfaction for the cultivars has been high with several producers indicating a strong demand, particularly for the Purple Majesty and the Masquerade. One operation, Jumping Good Goat Dairy, Ms. Dawn Jump, has utilized these cultivars in 1-2 acre plots for the past two years under organic production. She has been quite successful in marketing these potatoes from both the field, at harvest, and from the store during the year. Other locations utilizing these potatoes have included producers in Hesperus, Pagosa Springs, Gunnison, Dove Creek, Fort Collins, and Teller county. Additionally, this project was extended to include three producers as part of a Specialty Crops mini-grant from CSU for two years. Again, the project was aimed at introducing these cultivars and others to the general farmer's markets in the state, especially utilizing organic production techniques.

These four cultivars were also served during the week long Annual Potato Association of America meetings held in Denver, CO in August, 2012. Over 200 potato research scientists from North America and parts of the rest of the world attended. Each cultivar was served in a

different format (baked, mashed, boiled, etc.) and for different meals, but overall opinions of the taste, texture, etc. were rated extremely high by all participants at the conference.

Publications:

Masters' students Danny Iverson and Eric Larson worked closely on this project and will be including many of the results in their thesis.

Sections of this project and the sensory analysis will be presented at the Potato Expo in Las Vegas in January, 2013.

The findings were communicated to the Colorado producers during the annual Southern Rocky Mt. Ag Conference held in Monte Vista, CO in February, 2012.

Research Abstracts were submitted to the Western Agricultural Economics Association for inclusion in the summer meeting schedule.



Beneficiaries

The groups that will benefit from this project include all potato producers in Colorado and their buyers, private growers and gardeners in Colorado, and the base level North American consumer. There are an estimated 165 potato growers in Colorado and most work with a major warehouse to market commercial potatoes. This information will be developed and sent to the growers to help increase their knowledge base regarding potential branding of potatoes. It is of note that each of the cultivars selected has been widely accepted into the marketplace and there is a real momentum developing to brand the various cultivars and include their attributes. The Colorado Certified Potato Growers' Association developed an exclusive release with Albert Bartlett Company in Scotland for Purple Majesty potato. This cultivar is currently branded and sold as "Purple Majesty" in the U.K. and has received wide acceptance and a good knowledge base from the consumers on its great health attributes and flavor!

Another portion of this project which will be key to moving ahead with branding efforts in Colorado concerns the consumer survey's which were conducted. It is clear that consumers have a fairly well evolved sense of the various attributes potatoes bring to the table, but there is also a need to continue education, especially where various health attributes are concerned.

Lessons learned

There were two key objectives for the project which were instrumental in its success and acceptance by the industry. The first was to increase the planted acreage of the four project varieties with the intention of having adequate supply to use for continuing the necessary agronomic studies, for consumer marketing studies and testing, and on a limited basis test commercial marketing. This objective was met without difficulty as the needed seed and commercial testing quantities of the four varieties were produced and are currently in storage.

The second key objective involved testing the consumer message track that is being developed. The idea was to refine the consumer message so that consumer knowledge of potato nutrition and health attributes is being clearly received and understood. The consumer studies conducted have shown that a consumer's willingness to pay for different potato varieties is influenced by the consumer's initial sensory experience with a variety, their pre-existing knowledge of potato nutritional properties, a variety of demographic variables, and the consumer's exposure to additional nutritional information prior to purchase and consumption. For example it was discovered that consumers were willing to bid higher prices for the four varieties with a health attribute after receiving nutrition education and tasting the varieties. They were unwilling to do this with the control variety of Russet Burbank after the same procedure. This knowledge will help us move closer to achieving the goal of branding cultivars in Colorado.

Finally, this project showed that there is a continuing spectrum of activities which will need to take place to successfully implement "branding" of potato cultivars. For example, Jennifer Keeling-Bond left CSU employment mid-year of the final year of the project. It is critical to have additional help in place to navigate these issues as they come up. This precluded having the full consumer evaluations of the four cultivars completed and will require that this phase of the project be done by early 2013. Additionally, the bag labels for each cultivar were not completed and will require some additional work to have these prior to the evaluations. Finally, there is additional work needed to have the FDA accept and validate the nutritional guidelines as established in this project so that they are available for marketing and branding of the cultivars.

Contact person

Jim Ehrlich, Executive Director
Colorado Potato Administrative Committee (Area II)
719-852-3322
jerhlich@coloradopotato.org