PROJECT TITLE

FINAL REPORT

Nutritional Quality of Alaska Grown Produce

PROJECT IMPACT AND FINDINGS

The School of Natural Resources and Extension (SNRE) at University of Alaska Fairbanks (UAF) developed quantitative information on the nutritional content of locally grown produce versus imported produce available to Fairbanks consumers. Samples were collected throughout the season from local stores, farmers markets, and grown locally at UAF. The studied vegetable crops were tomatoes, colored bell peppers, English cucumbers, kale, butterhead- and romaine lettuce. °Brix analysis showed produce grown locally or obtained from the farmers market generally had higher sugar content than produce from local stores. Analysis for mineral nutrition included nitrogen, phosphorous, potassium, calcium, magnesium, sulfur, iron, manganese, boron, copper and zinc. Although the nutrient content varied among vegetables, the mineral levels for produce procured from farmers markets, local stores or locally grown within a particular crop were less variable. On a dry weight basis, butterhead- and romaine lettuce showed high values of N, P, K, Fe and Zn. As public awareness of nutrition and food security is increasing, documenting and evaluating the nutrient content of locally available produce is important for producers and consumers. At least four of ten producers presented with results from this study, indicated they will use nutrition as a marketing attribute. Fifty percent of consumers plan to more actively select Alaska grown produce based on information from this project on nutritional value. Additional studies will be conducted to further evaluate nutrient content of locally grown versus imported produce.

BENEFICIARIES

According to the 2012 Census of Agriculture (U.S. Department of Agriculture, 2014), there were 164 farms in AK that harvested vegetables for sale purposes. All of these farms could benefit from this type of information. In the Fairbanks area, 33 farms produced vegetables in 2013 (FEDC, 2014). Most of these farms sold directly to consumers through community supported agriculture (CSA), restaurants or farmers markets. Direct marketing works well for many local producers, although some have expressed an interest in opportunities to expand into other markets. There is currently also a lot of interest in using controlled environments, vertical farms and hydroponic indoor facilities for producing greens and other vegetables throughout the year. Similar to the produce grown in local fields, very limited information is available about the nutritional quality in lettuce, leafy greens and other crops produced in indoor farms.

A time frame greater than the length of this project is required to evaluate the anticipated wide-ranging impacts of the results. Additional studies on nutrient content, public knowledge and perceptions of fresh produce grown locally versus other production regions are likely to be further examined in future research projects.

Literature Cited

U.S. Department of Agriculture. 2014. 2012 Census of Agriculture. Available at: https://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_State_Level/Alaska/st02_1_038_038.pdf

Fairbanks Economic Development Corporation (FEDC). 2014. Demand for local produce in the Interior,

2014 market study. Available at: https://www.investfairbanks.com/sites/default/files/documents/Demand%20for%20Local%20Produce%20in%20the%20Interior%20-%202014%20Market%20Study_0.pdf

ACTIVITIES PERFORMED

OBJECTIVES

#	Objective	Completed? Yes	Completed? No*
1	Establish baseline data on nutritional quality of Alaska grown produce.	X	
2	Compare the nutritional quality of Alaska grown produce with produce brought in from outside.	X	
3	Develop and disseminate information on nutritional quality that may be used in marketing and pricing of Alaska grown produce. (This objective has been	X	X

ACCOMPLISHMENTS

Accomplishment	Relevance to Objective, Outcome, and/or Indicator
A total of 273 locally grown produce samples of tomatoes, lettuce, cucumbers, peppers, and kale were collected.	Nutritional content of produce grown at UAF was compared to produce obtained from farmers market and local stores.
Obtained 63 produce samples from farmers market and 90 samples from the grocery store.	Nutritional content of tomatoes, lettuce, cucumbers, peppers, and kale were compared among samples from farmers market, grocery stores and grown at UAF.
Preformed Brix tests on 62 samples.	Brix readings give an indication of the sugar content in a sample. These data provide a picture of the flavor potential for the produce obtained from the various sources. The outcomes vary with type and marketing outlet. However, produce grown locally or obtained from the farmers market generally has higher Brix readings than produce from the grocery store. Figures showing Brix values for bell peppers, tomatoes, cucumbers and butterhead lettuce are included at the end of this report.
Dried and ground 273 samples.	These are the initial steps for preparing samples for ICP-OES analysis.
Prepared 273 samples for ICP analysis.	These samples are ready for ICP-OES analysis.
Analyzed mineral nutrition in 273 samples	Samples were run for analysis of nitrogen, phosphorous, potassium, calcium, magnesium, sulfur, iron, manganese, boron, copper and zinc. Initially only six elements (P, K, Ca, Mg, Fe, Zn) were proposed for analysis. Nitrogen, sulfur, manganese, boron and copper were added to the

	final analyses. Although there were variations among vegetables, the mineral content for produce procured from farmers markets, local stores or locally grown within a particular crop was less variable. On a dry weight basis, butterhead- and romaine lettuce showed high values of N, P, K, Fe and Zn. Tables presenting the mineral nutrient analyses are included at the end of this report.
Progress toward targeted outcomes Of the 10 producers presented with the nutritional information developed here, at least 4 intend to use the information as an attribute in offering and marketing Alaska grown specialty crops. Of the 30 consumers presented with the nutritional information developed here, at least 15 are expected to more actively select Alaska grown specialty crops because of nutritional value.	Information from this project was presented at the 2017 Alaska Food Festival & Conference organized by the Alaska Food Policy Council. The presentation with the title Mineral Nutritional Quality of Alaska Produce was well received with the room filled to capacity of more than 30 participants. The greenhouse manager of Alaska Seeds of Change in Anchorage, Sundance Visser, was in attendance. She specifically indicated that they would be using the information in their operation to motivate and encourage the youth (ages 17 to 26) they engage in the production of lettuce and leafy greens. Alaska Seeds of Change will also use the nutritional information when offering their products for sale to the public. A business growing baby- and leafy greens year round for local marketing is starting up in Fairbanks. They will be using the nutritional information as they pursue various marketing strategies. The name of the owner and manager is Erica Mueller. The industry professionals for this project, Chris and John Dart, plan on using the information in their business Dart-AM Farms in Manley Hot Springs. They have been growing and marketing vegetables for many years. Being able to provide information on the nutrient content of their vegetables will give them an advantage in negotiating sales and contracts. Most of those attending the presentation at the 2017 Alaska Food Festival & Conference can be categorized as consumers. The majority indicated this was useful information for understanding the nutrient content of vegetables in general. Research results from the study could justify selecting and paying for the often more expensive Alaska grown vegetables as information on the nutrient content is available. We plan to continue working in this area and gain a better understanding of the nutritional quality in

	locally grown products compared to other sources. We plan on collecting additional vegetable samples from various local sources in coming seasons. We also plan to compare and evaluate hydroponic and indoor growing systems with traditional field production. Our findings will be assembled, published and made available to local consumers and producers.

CHALLENGES AND DEVELOPMENTS

Challenge	Corrective Actions
Staff changes. The personnel working on the project were all dedicated, conscientious and interested in completing the study. Unfortunately, several staff changes occurred for a variety of reasons during the course of the project. This slowed progress, as there was a continuous learning curve for collecting samples, recording data, lab work, and analyses.	As each change occurred, we immediately looked for employees with the required expertise. The hiring process is however, often slow and time consuming.
We encountered numerous issues with equipment, sample preparation, data recording and assessment. The MW680 laboratory microwave digester malfunctioned in the middle of the project. The instrument did not maintain the required temperatures for the preparation of samples. The instrument was returned to the manufacturer for repairs. When the digester was returned, it was still not functioning properly and needed to once again be returned for repair.	We took corrective actions as soon as an issue occurred. The distance from Alaska to authorized dealers and facilities slowed the process for proper repairs.
Ability to acquire sufficient amounts of comparable produce at similar times from the various sources. This was sometimes a challenge for samples from farmers markets and stores, as it was not known what exactly would be available on a particular sampling date.	We did our best in comparing similar types of produce throughout the season.
The slow progress and continuous delays in arriving at results on mineral nutrient content did not allow sufficient time to introduce and discuss findings with producers, buyers and consumers. As this component of the study is an indicator for gauging the success and impact of the project, the delay in data collection was unfortunate.	We have plans to continue working on determining mineral nutrient content in local produce. These efforts will include both field grown as well as indoor farming and hydroponic production techniques where various types of light emitting diodes and qualities are used. The data collected in this project are going to be further analyzed and findings made available to the public. Due to the limited time for proper data analysis, additional conclusions and outcomes that are beneficial for Alaska produce growers are likely to be uncovered. In the process of completing this project, we have gained research knowledge and capacity to more efficiently determine the factors that influence the

	mineral nutrient content of produce grown in Alaska and elsewhere. If it had not been for this project, it is unlikely we would have pursued or entered into this type of a research direction.

LESSONS LEARNED

It may be better to concentrate on one particular type of vegetable such as romaine lettuce or red beefsteak tomatoes rather than evaluating a range of crops. Working directly with local farmers may provide a more accurate estimate of nutrient content at the time of harvest throughout the season. On the other hand, this would be a more limited study that may not accurately describe or apply to produce that are available to consumers in local stores or the farmers market. A closer working relationship with produce managers of local grocery stores may also provide information about shipments and assistance in selecting types and produce samples for evaluation.

There were many staff changes during the project due to funding and organizational issues. Equipment failure and malfunctioning were unforeseen and further slowed progress. Safeguarding against these types of disruptions remains a challenge. Consistent staffing would have allowed the project to progress on schedule with timely analyses and thorough evaluations. This would have allowed sufficient time to prepare information for dissemination to communicate the results to the public.

CONTINUATION AND DISSEMINATION OF RESULTS

We have plans to continue working on determining mineral nutrient content in local produce. These efforts will include both field grown as well as indoor farming and hydroponic production techniques where various types of light emitting diodes and qualities are used. In the process of completing this project, we have gained research knowledge and capacity to continue working on determining the factors that influence the mineral nutrient content of produce grown in Alaska and elsewhere. If it had not been for this project, it is unlikely we would have pursued or entered into this type of a research direction.

Published documentation that shows the nutritional quality of locally grown produce can be expected to support the sale and often higher prices required for locally grown produce. This type of information can also lead to higher consumer demand for high quality food, which would increase retailers’ willingness to seek out and carry local products rather than items brought in to Alaska.

OUTCOMES AND INDICATORS/SUB-INDICATORS

OUTCOME MEASURES

Outcome Measures

Select the Outcome Measure(s) that were approved for your project.

- ☐ **Outcome 1**: Enhance the competitiveness of specialty crops through increased sales
- ☑ **Outcome 2**: Enhance the competitiveness of specialty crops through increased consumption
- ☐ **Outcome 3**: Enhance the competitiveness of specialty crops through increased access
- ☐ **Outcome 4**: Enhance the competitiveness of specialty crops though greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources
- ☐ **Outcome 5**: Enhance the competitiveness of specialty crops through more sustainable, diverse, and resilient specialty crop systems
- ☐ **Outcome 6**: Enhance the competitiveness of specialty crops through increasing the number of viable technologies to improve food safety
- ☐ **Outcome 7**: Enhance the competitiveness of specialty crops through increased understanding of the ecology of threats to food safety from microbial and chemical sources
- ☐ **Outcome 8**: Enhance the competitiveness of specialty crops through enhancing or improving the economy as a result of specialty crop development

OUTCOME INDICATORS

Outcome 2: Enhance the competitiveness of specialty crops through increased consumption

Indicator 3 Number of new and improved technologies and processes to enhance the nutritional value and consumer acceptance of specialty crops (excluding patents)

DATA COLLECTION

Samples of produce were collected on six occasions during the summer of 2017 in Fairbanks, AK. Samples were collected from various vendors at the Tanana Valley Farmers market and several Fairbanks grocery stores. The origin of the store samples varied and was sometimes unknown. A student who was not directly involved with the study selected 'good quality' samples. The locally grown samples were produced at UAF where we had control over management, production approach, harvesting and postharvest handling of produce and samples.

The fresh produce samples were brought to the lab at UAF and evaluated for °Brix as a measure of soluble solids. Sugars are usually the most abundant soluble solids and °Brix is expected to be a measure of the sugar content. °Brix was determined using a Spectrum Technologies refractometer. Fresh lettuce leaves or fruits (tomato, bell pepper, cucumber) were crushed and three separate samples of the sap were evaluated for °Brix. The average of the three recorded readings was used in the analysis. The remaining produce samples were dried at 70°C for three days. The dried samples were then ground using a stainless steel Wiley mill. The ground samples were stored until digested using a MW680 laboratory microwave digester. An ICP-Optical Emission Spectrometer (Varian ICP-OES 720-ES) was used for the mineral nutrient analyses.

Figures showing °Brix values for bell peppers, tomatoes, cucumbers and butterhead lettuce are included at the end of this report. The results from the mineral nutrient analyses are included and presented in Tables for red, orange and yellow bell peppers, red and orange tomatoes, cucumbers, butterhead- and romaine lettuce, and kale.

The analyses for sugar content (°Brix) suggest produce grown locally and available for purchase at farmers markets have slightly higher °Brix values for bell peppers, tomatoes, cucumbers and butterhead lettuce (Figures 1, 2, 3, 4). Although the soluble solids were significantly higher for locally available and grown produce, the differences in comparison to local store produce are small. For instance, the recorded values in tomatoes are 5.1 for locally grown and 3.4 for store bought. This difference is less than 2 °Brix units. The highest average °Brix was recorded for red bell peppers grown locally at 8.7. In comparison, the value is 5.8 for red bell peppers marketed through grocery stores. Considering the variations in types, cultivars and origin of the produce examined in this study, the relatively small differences suggest overall °Brix quality for produce available locally to be satisfactory.

The mineral nutrient contents for the various vegetables included in this study are presented in Tables 1, 2, 3 and 4. Although there were variations among vegetables, the mineral content for produce procured from farmers markets, local stores or locally grown within a particular crop was less variable. The highest amounts of nitrogen, phosphorous and potassium in percent of dry weight were recorded for butterhead- and romaine lettuce (Table 3). Iron content was also significantly higher with more than 200 ppm (parts per million) in the two types of lettuce. In comparison, the iron level in kale was about 100 ppm and bell peppers, tomatoes and cucumbers averaged 50 ppm (Tables 1 and 2). For the secondary macro-nutrients calcium, magnesium and sulfur, kale showed the highest contents (Table 4).

Manganese in lettuce and kale varied from about 45 to 70 ppm (Table 3 and 4), while levels of 12 to 28 ppm was recorded for peppers, tomatoes and cucumbers (Table 1 and 2). Cucumbers had a relatively high boron level that was similar to lettuce and kale at 26 to 32 ppm. Zinc varied from 20 ppm to the higher values of 46 ppm in romaine lettuce and 49 ppm in butter head lettuce. Copper levels were low in the produce evaluated with romaine lettuce having the highest amount at 11 ppm.

Since a range of minerals were analyzed, arriving at a conclusion that a particular crop or production location provides more nutritious produce is difficult. For instance, red bell peppers had in general the highest mineral content when obtained from a local store (Table 1). Orange bell peppers on the other hand, were more nutritious when they came from the farmers market and yellow peppers when they were grown locally.

Butterhead and romaine lettuce contained the highest recorded levels of several analyzed minerals. This may suggest that these types of vegetables would supply a significant amount of mineral nutrients in a diet. It may be sensible to keep in mind though, that these values are reported as percent of the dry weight. A large amount of butterhead lettuce may be needed to reach sufficient levels of dry matter and mineral content compared to for instance, the amount of dry weight and minerals contained in a tomato.

CONTACT PERSON

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EXPENDITURES TO DATE

EXPENDITURES

Cost Category	Amount Approved in Budget	Actual Federal Expenditures (Federal Funds ONLY)
Personnel	18,112	
Fringe Benefits	5,001	
Travel	0	
Equipment	0	
Supplies	3,980	
Contractual	0	
Other	0	
Direct Costs Sub-Total	27,093	
Indirect Costs	2,167	
Total Federal Costs	29,260	

Additional Information:

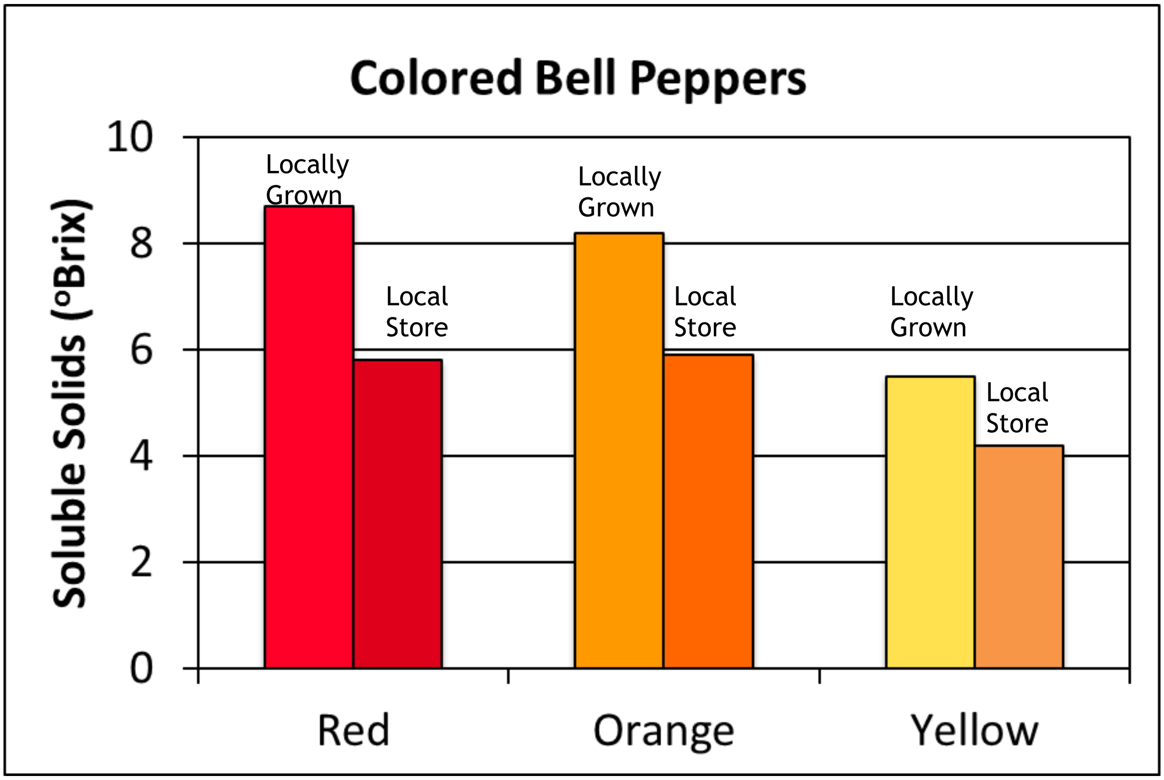

Figure 1. Soluble solids (°Brix) values as an indication of sugar content in colored bell peppers (red, orange or yellow) acquired from local stores or locally grown.

Figure 2. Soluble solids (°Brix) values as an indication of sugar content in red tomatoes (6-7 ounce, 170-200 grams) acquired from local stores, farmers market or locally grown.

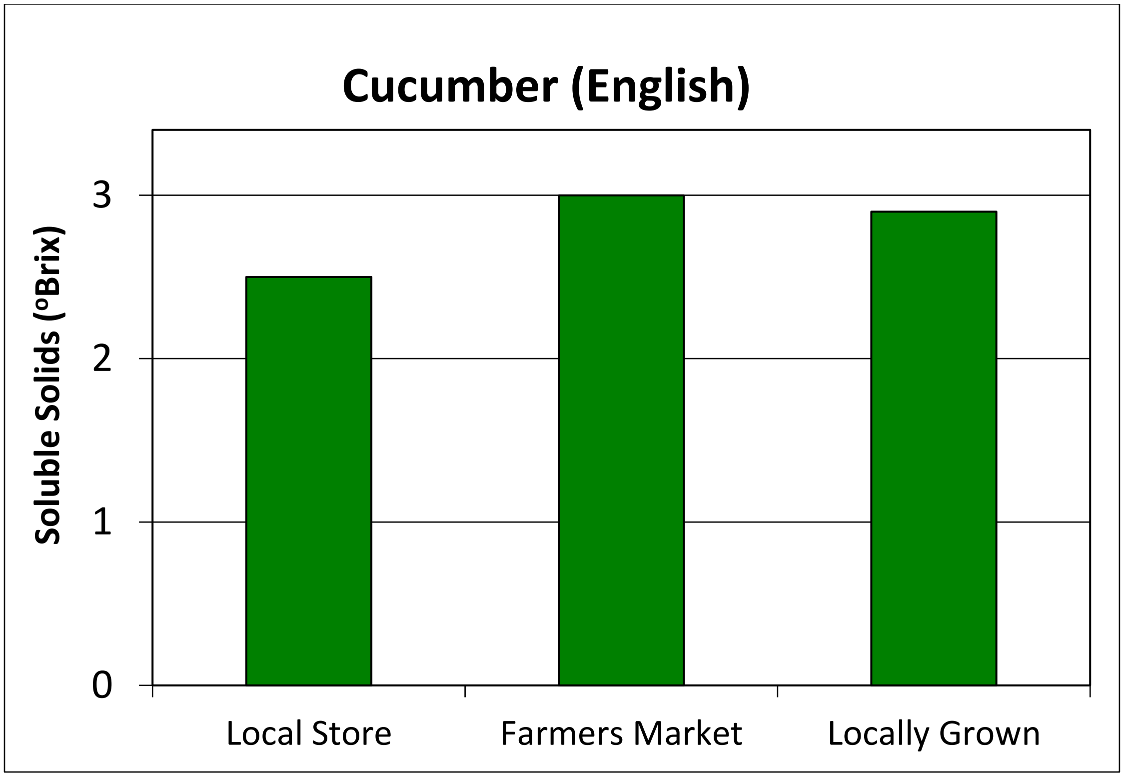

Figure 3. Soluble solids (°Brix) values as an indication of sugar content in English cucumbers acquired from local stores, farmers market or locally grown.

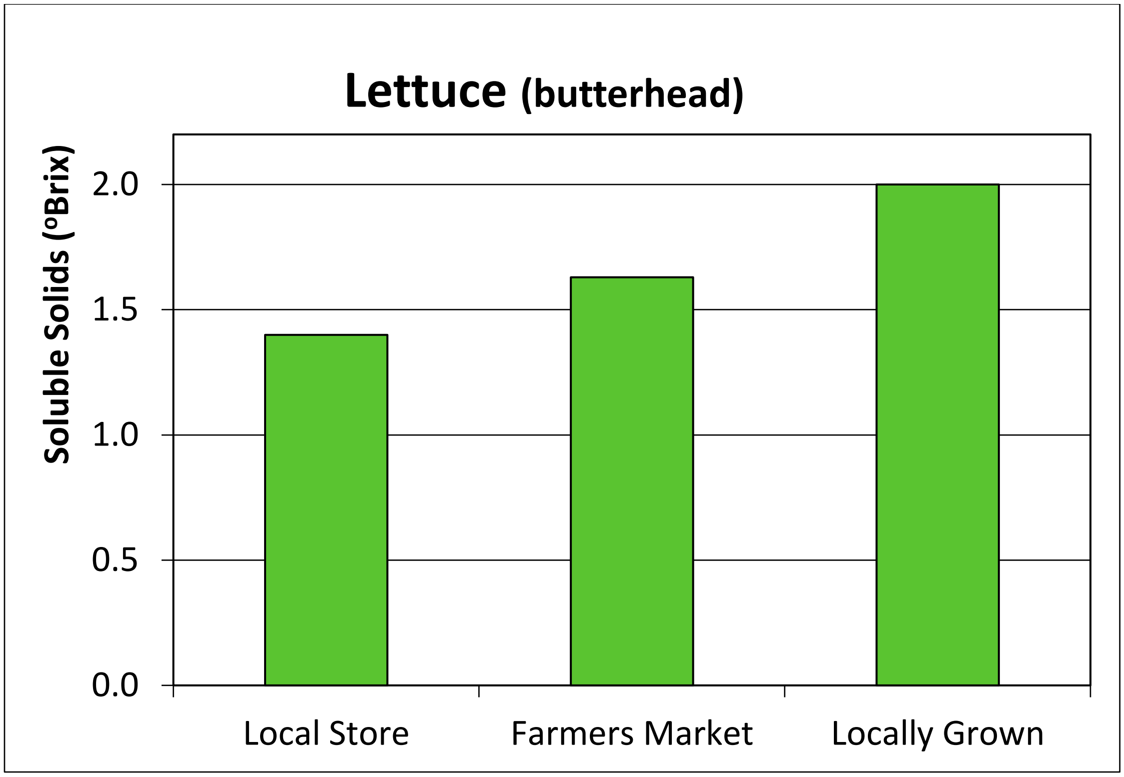

Figure 4. Soluble solids (°Brix) values as an indication of sugar content in butterhead lettuce acquired from local stores, farmers market or locally grown.

Table 1. Mineral nutrient content in colored (red, orange or yellow) bell peppers acquired from local grocery store, farmers market or locally grown. The results are indicated as percent (%) of dry weight for nitrogen, phosphorous, potassium, calcium, magnesium and sulfur, and in parts per million (ppm) of dry weight for iron, manganese, boron, copper and zinc. The results are presented as means ± standard error.

Mineral Nutrient	**Local Store**	**Farmers Market**	**Locally Grown**	**Average over Location**
Red Bell Pepper				
Nitrogen (%)	2.245 ± 0.015	2.135 ± 0.005	2.150 ± 0.270	2.177 ± 0.049
Phosphorous (%)	0.347 ± 0.078	0.349 ± 0.013	0.340 ± 0.021	0.345 ± 0.004
Potassium (%)	2.775 ± 0.445	2.550 ± 0.260	2.595 ± 0.395	2.640 ± 0.097
Calcium (%)	0.120 ± 0.040	0.090 ± 0.010	0.070 ± 0.020	0.093 ± 0.021
Magnesium (%)	0.144 ± 0.021	0.142 ± 0.003	0.124 ± 0.005	0.137 ± 0.009
Sulfur (%)	0.225 ± 0.041	0.201 ± 0.007	0.189 ± 0.019	0.205 ± 0.015
Iron (ppm)	53.30 ± 4.70	47.85 ± 2.35	50.15 ± 2.05	50.43 ± 2.234
Manganese (ppm)	19.45 ± 3.85	19.95 ± 5.25	11.55 ± 0.45	16.98 ± 3.847
Boron (ppm)	18.05 ± 4.15	13.05 ± 1.25	11.25 ± 0.15	14.12 ± 2.877
Copper (ppm)	4.30 ± 2.40	5.95 ± 2.25	7.45 ± 1.05	5.90 ± 1.286
Zinc (ppm)	33.45 ± 10.05	18.95 ± 5.15	21.20 ± 1.50	24.53 ± 6.372
Orange Bell Pepper				
Nitrogen (%)	2.015 ± 0.225	2.675 ± 0.185	2.010 ± 0.030	2.233 ± 0.312
Phosphorous (%)	0.332 ± 0.027	0.484 ± 0.015	0.313 ± 0.003	0.376 ± 0.077
Potassium (%)	2.635 ± 0.085	3.035 ± 0.065	2.430 ± 0.070	2.700 ± 0.251
Calcium (%)	0.090 ± 0.010	0.095 ± 0.025	0.060 ± 0.020	0.082 ± 0.015
Magnesium (%)	0.121 ± 0.011	0.202 ± 0.002	0.123 ± 0.002	0.149 ± 0.038
Sulfur (%)	0.195 ± 0.026	0.297 ± 0.024	0.194 ± 0.001	0.229 ± 0.048
Iron (ppm)	48.15 ± 7.25	71.65 ± 4.85	36.80 ± 3.60	52.20 ± 14.513
Manganese (ppm)	18.75 ± 0.25	19.75 ± 0.85	15.05 ± 0.55	17.85 ± 2.022
Boron (ppm)	14.65 ± 1.45	17.80 ± 0.80	11.50 ± 0.20	14.65 ± 2.572
Copper (ppm)	3.05 ± 1.55	9.35 ± 1.05	6.40 ± 0.10	6.27 ± 2.574
Zinc (ppm)	28.10 ± 1.60	35.05 ± 2.75	20.90 ± 1.30	28.02 ± 5.777
Yellow Bell Pepper				
Nitrogen (%)	2.320 ± 0.050	1.830 ± 0.360	2.795 ± 0.195	2.315 ± 0.394
Phosphorous (%)	0.372 ± 0.098	0.309 ± 0.056	0.529 ± 0.007	0.403 ± 0.093
Potassium (%)	3.050 ± 0.470	2.300 ± 0.340	3.520 ± 0.030	2.957 ± 0.502
Calcium (%)	0.135 ± 0.045	0.075 ± 0.015	0.140 ± 0.020	0.117 ± 0.030
Magnesium (%)	0.145 ± 0.016	0.119 ± 0.013	0.184 ± 0.006	0.149 ± 0.027
Sulfur (%)	0.248 ± 0.047	0.177 ± 0.047	0.314 ± 0.017	0.246 ± 0.502

Iron (ppm)	53.55 ± 5.95	42.20 ± 5.20	75.15 ± 5.05	56.97 ± 13.667
Manganese (ppm)	19.65 ± 3.05	16.60 ± 3.40	22.95 ± 2.05	19.73 ± 2.593
Boron (ppm)	18.50 ± 3.30	13.15 ± 4.95	20.00 ± 2.80	17.22 ± 2.940
Copper (ppm)	4.95 ± 3.45	3.75 ± 1.35	14.15 ± 0.55	7.62 ± 4.646
Zinc (ppm)	33.95 ± 1.15	23.60 ± 2.10	34.70 ± 1.40	30.75 ± 5.065

Table 2. Mineral nutrient content in red or orange tomatoes (6-7 ounce, 170-200 gram) and English cucumbers acquired from local grocery store, farmers market or locally grown. The results are indicated as percent (%) of dry weight for nitrogen, phosphorous, potassium, calcium, magnesium and sulfur, and in parts per million (ppm) of dry weight for iron, manganese, boron, copper and zinc. The results are presented as means ± standard error.

Mineral Nutrient	**Local Store**	**Farmers Market**	**Locally Grown**	**Average over Location**
Red Tomatoes				
Nitrogen (%)	2.505 ± 0.035	2.465 ± 0.025	2.310 ± 0.010	2.427 ± 0.084
Phosphorous (%)	0.466 ± 0.072	0.284 ± 0.104	0.439 ± 0.021	0.396 ± 0.080
Potassium (%)	4.120 ± 0.580	2.700 ± 0.740	3.525 ± 0.035	3.448 ± 0.582
Calcium (%)	0.195 ± 0.035	0.125 ± 0.005	0.140 ± 0.010	0.153 ± 0.030
Magnesium (%)	0.152 ± 0.006	0.149 ± 0.017	0.140 ± 0.001	0.147 ± 0.005
Sulfur (%)	0.187 ± 0.009	0.171 ± 0.007	0.184 ± 0.001	0.181 ± 0.007
Iron (ppm)	43.25 ± 0.65	51.55 ± 1.35	46.85 ± 3.35	47.22 ± 3.40
Manganese (ppm)	15.85 ± 0.05	11.05 ± 2.15	10.25 ± 0.35	12.38 ± 2.47
Boron (ppm)	14.05 ± 0.85	13.10 ± 4.10	18.15 ± 1.15	15.10 ± 2.19
Copper (ppm)	4.85 ± 2.75	6.15 ± 3.55	7.45 ± 1.05	6.15 ± 1.06
Zinc (ppm)	17.65 ± 2.75	20.85 ± 2.45	22.80 ± 1.60	20.43 ± 2.12
Orange Tomatoes				
Nitrogen (%)	2.585 ± 0.705	2.625 ± 0.205	2.235 ± 0.225	2.482 ± 0.175
Phosphorous (%)	0.524 ± 0.206	0.330 ± 0.009	0.486 ± 0.001	0.447 ± 0.084
Potassium (%)	4.260 ± 0.390	4.130 ± 0.130	3.605 ± 0.105	3.998 ± 0.283
Calcium (%)	0.145 ± 0.045	0.125 ± 0.015	0.105 ± 0.005	0.125 ± 0.016
Magnesium (%)	0.180 ± 0.050	0.194 ± 0.001	0.137 ± 0.013	0.170 ± 0.024
Sulfur (%)	0.197 ± 0.057	0.180 ± 0.007	0.198 ± 0.007	0.192± 0.008
Iron (ppm)	61.85 ± 1.15	68.80 ± 2.80	49.05 ± 8.85	59.90 ± 8.18
Manganese (ppm)	17.00 ± 7.20	10.80 ± 1.20	11.90 ± 0.40	13.23 ± 2.70
Boron (ppm)	15.75 ± 0.45	8.75 ± 1.15	14.90 ± 2.30	13.13 ± 3.12
Copper (ppm)	7.20 ± 1.10	8.45 ± 0.05	7.40 ± 1.40	7.68 ± 0.55

Zinc (ppm)	26.75 ± 7.05	26.85 ± 1.85	21.85 ± 3.65	25.15 ± 2.33
English Cucumber				
Nitrogen (%)	3.560 ± 0.300	2.460 ± 0.240	4.270 ± 0.120	3.430 ± 0.745
Phosphorous (%)	0.929 ± 0.016	0.422 ± 0.051	0.988 ± 0.005	0.780 ± 0.254
Potassium (%)	5.500 ± 0.710	3.980 ± 0.100	5.390 ± 0.060	4.957 ± 0.692
Calcium (%)	0.670 ± 0.140	0.485 ± 0.135	0.580 ± 0.020	0.578 ± 0.076
Magnesium (%)	0.361 ± 0.009	0.329 ± 0.024	0.333 ± 0.018	0.341 ± 0.014
Sulfur (%)	0.395 ± 0.302	0.331 ± 0.029	0.484 ± 0.014	0.403 ± 0.063
Iron (ppm)	56.65 ± 9.35	49.60 ± 12.60	59.40 ± 7.20	55.22 ± 4.13
Manganese (ppm)	29.70 ± 4.20	14.80 ± 1.50	40.90 ± 0.70	28.47 ± 10.69
Boron (ppm)	32.10 ± 4.40	20.25 ± 4.35	40.95 ± 2.05	31.10 ± 8.48
Copper (ppm)	6.90 ± 2.80	4.75 ± 0.35	9.10 ± 0.80	6.92 ± 1.78
Zinc (ppm)	30.65 ± 3.05	27.05 ± 0.05	43.45 ± 3.55	33.72± 7.04

Table 3. Mineral nutrient content in lettuce (butter-head or Romaine) acquired from local grocery store, farmers market or locally grown. The results are indicated as percent (%) of dry weight for nitrogen, phosphorous, potassium, calcium, magnesium and sulfur, and in parts per million (ppm) of dry weight for iron, manganese, boron, copper and zinc. The results are presented as means ± standard error.

Mineral Nutrient	Local Store	Farmers Market	Locally Grown	Average over Location
Butterhead Lettuce				
Nitrogen (%)	4.715 ± 0.995	4.875 ± 0.295	5.520 ± 0.240	5.037± 0.348
Phosphorous (%)	0.737 ± 0.027	0.775 ± 0.138	0.820 ± 0.067	0.777 ± 0.034
Potassium (%)	5.020 ± 0.760	5.200 ± 0.320	7.690 ± 0.020	5.970 ± 1.218
Calcium (%)	1.000 ± 0.340	0.640 ± 0.110	0.925 ± 0.065	0.855 ± 0.155
Magnesium (%)	0.337 ± 0.062	0.297 ± 0.014	0.318 ± 0.015	0.317 ± 0.016
Sulfur (%)	0.284 ± 0.003	0.331 ± 0.021	0.310 ± 0.015	0.308 ± 0.019
Iron (ppm)	115.70 ± 30.30	362.00 ± 24.00	153.50 ± 32.50	210.4 ± 108.3
Manganese (ppm)	80.80 ± 45.20	46.00 ± 12.10	84.55 ± 49.45	70.45 ± 17.36
Boron (ppm)	26.20 ± 3.40	25.45 ± 0.45	30.35 ± 0.35	27.33 ± 2.16
Copper (ppm)	5.20 ± 2.20	7.30 ± 0.01	12.10 ± 2.30	8.20 ± 2.89
Zinc (ppm)	31.80 ± 12.60	62.85 ± 5.05	52.05 ± 10.95	48.90 ± 12.87
Romaine Lettuce				
Nitrogen (%)	4.485 ± 0.435	4.920 ± 0.120	5.320 ± 0.300	4.908 ± 0.341
Phosphorous (%)	0.469 ± 0.004	0.436 ± 0.062	0.603 ± 0.038	0.503 ± 0.072
Potassium (%)	4.730 ± 0.030	4.055 ± 0.285	7.950 ± 0.380	5.578 ± 1.700

Calcium (%)	0.675 ± 0.135	0.795 ± 0.135	1.045 ± 0.025	0.838 ± 0.154
Magnesium (%)	0.319 ± 0.041	0.485 ± 0.027	0.365 ± 0.080	0.390 ± 0.070
Sulfur (%)	0.356 ± 0.122	0.340 ± 0.038	0.413 ± 0.073	0.370 ± 0.031
Iron (ppm)	286.00 ± 50.0	302.50 ± 11.50	265.50 ± 46.50	284.67 ± 15.14
Manganese (ppm)	57.20 ± 1.30	38.50 ± 2.00	65.50 ± 2.50	53.73 ± 11.30
Boron (ppm)	20.50 ± 1.50	22.50 ± 4.50	36.25 ± 4.75	26.42 ± 7.00
Copper (ppm)	8.60 ± 1.80	9.55 ± 1.05	16.05 ± 2.35	11.40 ± 3.31
Zinc (ppm)	44.60 ± 2.20	34.90 ± 0.70	58.60 ± 1.10	46.03 ± 9.73

Table 4. Mineral nutrient content in kale (green or red) acquired from local grocery store, farmers market or locally grown. The results are indicated as percent (%) of dry weight for nitrogen, phosphorous, potassium, calcium, magnesium and sulfur, and in parts per million (ppm) of dry weight for iron, manganese, boron, copper and zinc. The results are presented as means ± standard error.

Mineral Nutrient	**Local Store**	**Farmers Market**	**Locally Grown**	**Average over Location**
Green Kale				
Nitrogen (%)	3.855 ± 0.115	4.855 ± 0.055	4.625 ± 0.275	4.445 ± 0.428
Phosphorous (%)	0.385 ± 0.003	0.380 ± 0.004	0.378 ± 0.002	0.381 ± 0.003
Potassium (%)	2.480 ± 0.020	3.985 ± 0.045	3.315 ± 0.085	3.260 ± 0.616
Calcium (%)	1.505 ± 0.005	2.115 ± 0.005	1.925 ± 0.195	1.848 ± 0.255
Magnesium (%)	0.444 ± 0.005	0.600 ± 0.001	0.528 ± 0.076	0.524 ± 0.064
Sulfur (%)	1.560 ± 0.003	1.620 ± 0.010	1.620 ± 0.020	1.600 ± 0.028
Iron (ppm)	92.55 ± 2.55	92.95 ± 1.85	87.55 ± 5.55	91.02 ± 2.46
Manganese (ppm)	46.95 ± 0.15	43.25 ± 0.65	45.15 ± 1.05	45.12 ± 1.51
Boron (ppm)	42.05 ± 0.25	8.80 ± 0.30	26.05 ± 2.75	25.63 ± 13.58
Copper (ppm)	2.85 ± 0.05	3.10 ± 0.01	2.85 ± 0.25	2.93 ± 0.12
Zinc (ppm)	20.95 ± 0.45	21.45 ± 0.15	22.50 ± 0.50	21.63 ± 0.65
Red Kale				
Nitrogen (%)	3.800 ± 0.670	4.490 ± 0.040	5.790 ± 0.670	4.693 ± 0.825
Phosphorous (%)	0.301 ± 0.009	0.457 ± 0.095	0.718 ± 0.128	0.492 ± 0.17
Potassium (%)	2.610 ± 0.760	3.300 ± 0.440	3.440 ± 0.470	3.117 ± 0.36
Calcium (%)	3.140 ± 0.090	3.170 ± 0.290	2.820 ± 0.140	3.043 ± 0.16
Magnesium (%)	0.739 ± 0.158	0.436 ± 0.216	0.370 ± 0.133	0.515 ± 0.16
Sulfur (%)	2.420 ± 0.440	1.429 ± 0.831	1.093 ± 0.438	1.647 ± 0.56
Iron (ppm)	124.50 ± 3.50	110.55 ± 15.45	100.55 ± 0.15	111.87 ± 9.82
Manganese (ppm)	65.20 ± 15.50	55.90 ± 34.40	66.75 ± 43.25	62.62 ± 4.80

Boron (ppm)	38.60 ± 7.20	18.80 ± 6.60	38.80 ± 11.00	32.07 ± 9.38
Copper (ppm)	2.90 ± 0.30	3.95 ± 0.35	5.55 ± 0.55	4.13 ± 1.09
Zinc (ppm)	23.05 ± 2.45	27.80 ± 1.40	31.45 ± 3.35	27.43 ± 3.44