

## **Educating Farmers' Market Consumers on Best Practices for Retaining Maximum Nutrient and Phytonutrient Levels in Local Produce**

### **Abstract**

Few farmers' market consumers are aware of how to retain optimal nutritional quality of produce following purchase. Our objective was to develop and evaluate educational materials intended to inform market consumers about best practices for storing, preserving, and consuming local produce to maximize nutrients and phytonutrients. Printed educational materials were developed and then evaluated via a survey of and interviews with Ohio farmers' market consumers. The materials were modified to reflect consumer comments, and finalized materials were distributed to farmers' markets throughout Ohio. The approach we used can be applied by other Extension professionals when developing educational materials for different audiences.

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### **Introduction**

Farmers' markets, community-supported agriculture programs, and produce auctions have become

more popular in recent years due to growing consumer interest in fresh foods and locally produced fruits and vegetables (Martinez et al., 2010). The U.S. Department of Agriculture reports that the number of farmers' markets in the United States more than doubled from 2004 to 2014, with 8,268 markets existing in 2014 (U.S. Department of Agriculture, Agricultural Marketing Service, 2014). Community-supported agriculture programs have increased in a similar manner (Martinez et al., 2010). Social efforts have prompted consumers to seek local produce to achieve improved freshness and to support the local economy (Food Marketing Institute Research, 2009; Govindasamy, Italia, & Adelaja, 2002; Martinez et al., 2010). Consumers are willing to pay a higher price for local produce because of perceived improved quality, freshness, and nutrition and reduced environmental impacts (Brown, 2003; Carpio & Isengildina-Massa, 2009; Loureiro & Hine, 2002). Although farmers' market consumers may consider locally grown fresh produce to be more healthful, nutritional value is greatly affected by postharvest handling and cooking methods. Few consumers have knowledge about how to retain optimal nutritional quality following harvest or purchase (Remley, Goard, Taylor, & Ralston, 2015).

A recent study suggested that Ohio farmers' market consumers preserve fresh produce at least once per year but that 75% do not understand that retention levels for nutrients and phytonutrients (natural compounds in plants that can have health benefits when consumed by people) depend on the type of produce and the preservation technique used (Remley et al., 2015). Study respondents were interested in learning about nutrient retention in produce and how best to store, consume, and preserve produce to maximize nutrient and phytonutrient retention (Remley et al., 2015). They were most interested in learning about foods in relation to body weight and heart disease and less interested in learning about foods related to diabetes, blood pressure, cancer, energy, and osteoporosis (Remley et al., 2015). The study also examined consumers' and farmers' market managers' preferences regarding the format of relevant educational materials. Both groups expressed preference for postcard-type print materials distributed via individual vendor booths or a website that included facts and recipes (Remley et al., 2015).

The study discussed in this article was conducted to develop and evaluate educational materials intended to inform farmers' market consumers about best practices for storing, preserving, and consuming local produce to maximize nutrient and phytonutrient levels. Social marketing theory guided the development of the educational materials and strategies for engaging the primary target audience, adult consumers who procure local produce at farmers' markets. Social marketing theory considers an audience's characteristics (demographics, knowledge levels, opinions) and motivations (interests, health concerns) along with barriers, such as inadequate access to information relevant to the desired behavior (in this case, maximizing nutritional values of produce) (Grier & Bryant, 2005). The goal was that after using the educational materials, study participants would be able to identify the best practices for storing, preserving, and consuming fruits and vegetables for optimal nutrient and phytonutrient delivery. Longer term, we see potential for this increased awareness to influence local food purchase decisions, improve dietary patterns, increase nutrient/phytonutrient delivery, and, ultimately, increase the ability of the consumer to use local fruits and vegetables for a greater portion of the year by means of more efficient storage options.

## Methods

The development of the educational materials was informed by the results of the previous research survey of farmers' market consumers and managers (Remley et al., 2015) and by social marketing principles (Grier & Bryant, 2005). Specific factors considered during development of the materials were (a) need to appeal to an educated audience; (b) content focused on foods rather than nutrients; (c) appropriateness of materials for both print (large postcard size) and web publication; (d) inclusion of a combination of facts, recipes, and links to additional information; (e) distribution of materials through individual farmers' market vendors; and (f) appropriateness of material characteristics (i.e., materials printed on thick paper, container provided to minimize disturbance by wind).

A list of produce commonly available at Ohio farmers' markets was generated. Then the foods on the list were categorized into 13 groups on the basis of use and nutrient and phytonutrient profiles. In addition, an introduction was developed to define terms; to provide an evidence-based overview of the impact of cooking and preservation on nutrient and phytonutrient levels; and to identify the nutrients, phytonutrients, and health benefits associated with each category of food. The resulting 14 topics for the educational materials were

- introduction to the health benefits of and nutrient and phytonutrient changes that can occur in produce;
- apples, apricots, peaches, pears, and plums;
- asparagus;
- beets;
- berries (blackberries, blueberries, raspberries, and strawberries);
- carrots, sweet potatoes, and winter squash;
- cherries (sweet cherries and tart cherries);
- cruciferous vegetables (broccoli, brussels sprouts, cabbage, cauliflower, collard greens, kale, kohlrabi, mustard greens, radishes, rutabagas, turnip greens, and turnips);
- dark green leafy vegetables (beet greens, chicory, cress, dandelion, endive, escarole, spinach, sorrel, swiss chard, etc.);
- green beans and pea pods;
- melons (cantaloupes, honeydew melons, and watermelons);
- peppers (hot peppers and sweet bell peppers);
- sweet corn; and

- tomatoes.

The content of the educational materials was based on information gathered by searching published peer-reviewed and gray literature. Common storage options (fresh at room temperature, fresh at refrigerated temperature, canned at room temperature, and frozen); cooking methods (steaming, sautéing, boiling, microwaving, roasting, and grilling); preservation methods (canning [including pickling], freezing, and drying); and other preparation methods (chopping, draining, and blanching) were investigated. Information was collected by searching the Pubmed database and reputable websites and from organizations, including the U.S. Department of Agriculture, the U.S. Food and Drug Administration, the American Institute for Cancer Research, and Ohio State University (OSU) Extension.

The educational materials were developed by two research team members who have training in nutrition (authors RR, MO) and were reviewed and edited by the other investigators (authors DR, LG, CT). The material for each topic was developed to fit on a 5-by-7 in. card, and each food category card included seven distinct sections: (a) introduction to the fruit or vegetable category; (b) summary of how the food improves health; (c) text and a table identifying the nutrient and phytonutrient changes that occur with storage, preparation, cooking, and preservation; (d) recipe that maximizes the nutrient and phytonutrient content of the food; (e) graphic identifying other foods containing the same primary nutrients and phytonutrients; (f) disclaimer stating that the materials are not meant to diagnose, treat, cure, or prevent any disease; and (g) Quick Response (QR) code and URL of the website where additional information can be found (<http://localfoods.osu.edu/maximizenutrients>). Nutrients were included on the basis of whether the food provided at least 10% of the U.S. Food and Drug Administration's recommended daily value for the nutrient (percentage of daily value was chosen because of its inclusion on food labels), and the primary phytonutrient(s) were identified. The educational materials were then printed on 5-by-7 in. cardstock. An example draft version of a card is presented in Figure 1. (Figure 1 also shows an example final version, which will be discussed later.)

**Figure 1.**

Relationship Between Personal Sustainability and Organizational Sustainability

**First Draft**

**Final**

**Front of card:**

Red tomatoes are well known for their large amounts of the phytochemical lycopene, a type of carotenoid that gives tomatoes their red color. They also contain other carotenoid pigments that might have health benefits. Tomatoes are a great source of vitamins A, C, and K, and potassium. In fact, a half cup of raw tomato (1 small tomato) provides 20% of your daily vitamin C needs and 15% of your daily vitamin A needs.

## Farm to Health Series

**MAXIMIZE YOUR NUTRIENTS FROM:  
RED TOMATOES**

**NUTRIENT AND PHYTOCHEMICAL CHANGES**

For best flavor and highest carotenoid levels in fresh tomatoes, pick when ripe and red. They will continue to ripen at home if stored at room temperature, but little additional flavor develops after harvest. Light cooking or canning can increase the amount of lycopene with only minimal impact on the other nutrients. Eating tomatoes with a little oil can help absorb the carotenoids better.

	Vit C	Vit K	Vit A	Lycopene	Potassium
Fresh, room temp storage	↓	=	=	↑	=
Refrigerated, chopped storage	=	=	↓	↓	=
<b>Cooking:</b>					
Lightly sautéed	↓	=	=	↑	=
Roasted or grilled	↓	=	↓	↑	=
Boiled, drained	↓	=	=	↓	↓
Boiled, liquid consumed	↓	=	=	↑	=
<b>Canned:</b>					
Drained	↓	=	↓	↓	↓
Liquid consumed	↓	=	↓	↑	=
Dried	↓	↓	↓	↓	↑

*This information is not meant to diagnose, treat, cure, or prevent any disease. This project is made possible by funding through OSU CARES - an initiative of OSU Extension and the Ohio State University to expand faculty, staff and student partnerships with communities throughout Ohio.*

Red tomatoes are known for large amounts of the phytonutrient lycopene, a type of carotenoid that gives tomatoes their red color. One small tomato provides:

- 20% of daily vitamin C needs.
- 15% of daily vitamin A needs.

**Recipe on Back!**

## Farm to Health Series

**MAXIMIZE YOUR NUTRIENTS FROM:  
RED TOMATOES**

**NUTRIENT AND PHYTONUTRIENT CHANGES**

For best flavor and highest lycopene levels in fresh tomatoes, pick when ripe and red. They will continue to ripen at home if stored at room temperature.

- Lightly cooked and canned tomatoes are a good option for optimizing lycopene content. However, there is some loss of vitamins A and C. Vitamin C is better preserved when canned or cooking liquid is consumed.
- Eating tomatoes with a little oil can help your body absorb the lycopene.
- Drying causes significant losses in vitamin C and vitamin A. Choose other preservation methods to maximize nutrient and phytonutrient content.

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**Back of card:**

### Recipe: Super-Bowl Tomato Soup

*(Reprinted with permission from the American Institute for Cancer Research, [www.aicr.org](http://www.aicr.org))*

- To maximize the nutritional value, this recipe uses canned tomatoes and tomato juice, and includes oil.

**Ingredients:**

- 1 Tbsp. extra virgin olive oil
- 1 cup chopped onion
- 1/3 cup chopped scallions, green and white parts
- 1 (28-oz.) can no-salt added whole tomatoes in tomato sauce
- 3 marinated sun-dried tomato halves, rinsed and chopped
- 1 tsp. dried basil
- 1/2 tsp. sugar
- 1 cup low-sodium tomato juice
- Salt and freshly ground pepper
- Garlic croissants, if desired, for garnish

**Directions:**

- In small Dutch oven or large, heavy saucepan, heat oil over medium-high heat. Add onions and scallions, and cook until onions are soft, about 5 minutes, stirring occasionally. Add tomatoes one at a time, holding each over the pot and crushing it through your fingers. Add tomato sauce remaining in can. Add sun-dried tomatoes, basil, and sugar. Bring to a boil, reduce heat, cover and simmer soup for 20 minutes.
- Using immersion blender, food processor or regular blender, puree soup until it is pulpy to smooth, as you prefer. Blend in tomato juice. Season soup to taste with salt and pepper. Serve immediately, garnished with croissants, if using. Or cool soup and refrigerate, tightly covered, for up to 3 days.

**Makes 6 servings. Per serving:** 71 calories, 2.5 g fat (< 1g sat fat), 12g carbohydrates, 2g protein, 2g fiber, 64mg sodium, 440 IU vitamin A (8% DV), 32mg vitamin C (53% DV), 35µg vitamin K (44% DV), 488mg potassium (14% DV)

**OTHER FOOD SOURCES OF KEY NUTRIENTS AND PHYTOCHEMICALS:**

**Lycopene**

Watermelon

Red Grapefruit

**Vitamin C**

Bell Peppers

Strawberries

Broccoli

### Recipe: Super-Bowl Tomato Soup

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**Lycopene**

Watermelon

Red Grapefruit

**Vitamin C**

Bell Peppers

Strawberries

Broccoli

To evaluate the face validity of the educational materials, questions for a short survey and an associated interview were developed and were based on prior research with farmers' market consumers and managers (Remley et al., 2015) and social marketing theory principles (Grier & Bryant, 2005). The survey consisted of 13 multiple-choice questions related to consumers' opinions of the content, format, and comprehensibility of the material as well as questions related to demographic information (see Table 1 for example questions). Four open-ended questions were asked during the interviews:

- Please tell me what your overall first reaction is to the handout.
- Please tell me what you like and what you don't like about the handout.
- Please tell me what you learned from the handout.
- Can you give me any ideas to make this handout better?

The survey and interview questions were peer-reviewed by Extension colleagues. Development of the survey and training of the interviewers were addressed by four research team members (authors RR, MO, LG, DR) and guided by a research team member with extensive experience in

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survey design and qualitative research (author CT). The project was approved with exempt status by the Institutional Review Board.

**Table 1.**

Categories and Examples of Multiple-Choice Questions Used in the Survey

Category	Question(s) <sup>a</sup>
Format and content of educational material	<p>Was the amount of information included on the nutrition education handout appropriate?</p> <p>Was the 5x7 postcard format of the printed nutrition education handout appropriate for a farmers' market?</p> <p>What did you think about the amount of images?</p> <p>What do you think about the table?</p>
Comprehensibility of educational material	<p>Could you understand the information on the educational handout?</p> <p>Berries:</p> <p style="padding-left: 40px;">Berries might be associated with reduced incidence of what disease?</p> <p style="padding-left: 40px;">For phytonutrient and nutrient retention of preserved berries, how is it best to eat them?</p> <p>Tomatoes:</p> <p style="padding-left: 40px;">Tomatoes are associated with reduced risk of what disease?</p> <p style="padding-left: 40px;">Can lycopene in tomatoes continue to increase when stored on the kitchen counter?</p> <p style="padding-left: 40px;">Which is the best way to maximize the amount of lycopene when eating tomatoes?</p> <p>Cruciferous vegetables:</p> <p style="padding-left: 40px;">Broccoli is one type of cruciferous vegetable. What are other vegetables in this family?</p> <p style="padding-left: 40px;">What is the best way to cook broccoli to maximize the amount of vitamin C and glucosinolates (phytonutrients)?</p>

	According to the education card, eating broccoli might help protect against what disease?
Utility of educational material	How likely are you to use the information on this card when making decisions on how to use produce?
Demographics	<p>What is your gender?</p> <p>How old are you?</p> <p>Do you receive food assistance?</p> <p>What is your current employment status?</p> <p>What is the highest degree or level of school you have completed?</p>
<p><sup>a</sup>Respondents were asked to select only one response to each question.</p>	

Following the initial development of the materials, draft 5-by-7 in. cards on the topics of cruciferous vegetables, tomatoes, and berries were taken to two Ohio farmers' markets (one suburban and one rural) during summer 2013. Feedback was solicited from a convenience sample of 20 farmers' market consumers. Each consumer read one of the three cards and then completed the survey and then the audio-recorded interview. Completion of the survey and the interview took each participant approximately 10–20 min. Individuals received a \$10 farmers' market voucher for their participation.

Survey results were tallied using descriptive statistics. Thematic analysis was used to qualitatively categorize the data from the interview into usable information (Corbin & Strauss, 1990). Comments from the interviews were reviewed and organized into four themes: format and organization, table identifying nutrient and phytonutrient changes, recipe, and overall content. In addition, the educational materials were peer-reviewed by colleagues following the OSU Family and Consumer Sciences process. The educational materials were then revised to reflect the results of the survey, interviews, and peer review.

## Results and Discussion

### Demographics of Sample

Overall, 20 farmers' market consumers completed the survey and interview. The demographics of the group are shown in Table 2. The market consumers primarily were female, aged 51 to 70 years, not receiving food assistance, employed full-time, and educated with at least a Bachelor's degree (most held a graduate or professional degree).

**Table 2.**

### Demographics of Farmers' Market Consumers

Demographic descriptor		Response <i>n</i> = 20 (%)
Gender	Female	14 (70%)
Age	18–25 years	0 (0%)
	26–30 years	2 (11%)
	31–50 years	4 (21%)
	51–70 years	12 (63%)
	71 years	1 (5%)
Food assistance	Receives assistance	3 (16%)
Employment status	Full-time	12 (63%)
	Part-time	1 (5%)
	Retired	3 (16%)
	Unemployed	2 (11%)
	Other	1 (5%)
Education level	Some high school	0 (0%)
	High school degree or GED	4 (21%)
	Some college or 2-year degree	4 (21%)
	Bachelor's degree	5 (26%)
	Graduate or professional degree	6 (32%)

## Survey, Interview, and Peer Review Results

Overall, 80% of the survey respondents reported that they were at least somewhat likely to use the information on the educational card when deciding how to use produce. All or most respondents thought the amount of information (100%), the 5-by-7 in. format (90%), and the number of images (95%) were appropriate, compared to only 80% who indicated that the table was easy to



understand. Respondents answered 81% of the comprehension questions correctly. They tended to answer questions relating to a food's association with a disease correctly but were less accurate about how nutrients change during storage or preservation.

Table 3 summarizes the positive and negative interview comments about the educational materials (in addition to resulting changes, which will be discussed later). In general, results from the interviews demonstrated that consumers found the materials attractive, easy to understand, well-organized, succinct, and inclusive of relevant and interesting information. Consumers particularly liked the recipes. All participants were able to list several pieces of information they learned by reading the materials. The more common ideas about aspects of the materials needing improvement (each indicated by at least three respondents) were that at first glance the card appeared to include too much information and that the table was difficult to follow. Less common ideas about aspects of the materials needing improvement (each indicated by one or two respondents) were that there could be more images, the sections could be more clearly defined, the font size could be enlarged, the amount of text could be reduced, and the table could be condensed.

**Table 3.**

Comments from Interviews with Farmers' Market Consumers (*n* = 20) and Resulting Changes

<b>Category</b>	<b>Positive comment(s)</b>	<b>Negative comments</b>	<b>Changes made in response to comments</b>
Format and organization	The use of color and images makes it attractive. ( <i>n</i> = 11)	At first glance, it looks like too much information. There is too much text. ( <i>n</i> = 5)	The use of names of phytonutrients and other technical terms was minimized, reducing the total amount of text.
	It is easy to see and read—good use of bullet points and sections. ( <i>n</i> = 6)	It could use more images. ( <i>n</i> = 2)	No change
	It is succinct and not overwhelming. ( <i>n</i> = 4)	The sections could be more clearly defined. ( <i>n</i> = 2)	Sections were clearly defined through the addition of colored boxes around text.
	It is organized well, familiar looking, and easy to follow. ( <i>n</i> = 3)	The font size is too small. ( <i>n</i> = 2)	The font size was increased on the front of the card.
	The card is a good size. ( <i>n</i> = 2)	The "other food sources" graphic could be moved to the front of the card. ( <i>n</i> = 1)	No change

Table showing nutrient and phytonutrient changes	The table made it easy to see the best way to prepare produce to get the most nutrients. ( <i>n</i> = 4)	The table is difficult to understand, especially the arrows. It needs a key. It could be condensed. ( <i>n</i> = 11)	First, the table was simplified, and a key for defining the symbols was added. Following peer review, the table was replaced with simpler text.
		Storage could be added as a category in the table. ( <i>n</i> = 1)	No change
Recipe	The recipe is useful. ( <i>n</i> = 6)	A second, short recipe could be added. ( <i>n</i> = 1)	No change
		The recipe had too many ingredients. ( <i>n</i> = 1)	No change
		The recipe includes too much sugar. ( <i>n</i> = 1)	No change
		The recipe could be moved to the front of the card to entice consumers to take a card. ( <i>n</i> = 1)	A callout was added on the front to notify the reader that a recipe is on the back.
Overall content	It included interesting information. ( <i>n</i> = 15)	A statement about food interactions should be added. ( <i>n</i> = 1)	No change
	It is easy to understand. ( <i>n</i> = 4)	Details and references to specific studies could be added. ( <i>n</i> = 1)	No change
	It is nice to have information on foods that you can purchase at the market. ( <i>n</i> = 3)	It might not be necessary to include the names of the phytonutrients. ( <i>n</i> = 1)	Use of the names of phytonutrients was minimized.

	Link to website was useful. (n = 1)	Specific varieties that are best for eating fresh versus canning could be identified. (n = 1)	No change
<i>Note.</i> Sentences were paraphrased from the actual comments from consumers so that ideas could be collated.			

During the peer review, the materials garnered generally positive comments, with the exception of comments about the complexity of the table and the high reading level and technical language of the text.

## Interpretation of Findings and Development of Finalized Educational Materials

Overall, consumers approved of the general appearance and format of the educational materials and were interested in the content. It is noteworthy that consumers appreciated the presence of a recipe as this interest in a recipe may encourage a consumer to take a card and read the rest of the material. Inclusion of a recipe also provides the consumer with a practical recipe that incorporates cooking and preservation strategies that optimize nutrient and phytonutrient levels. Because the recipe attracted consumers, the recipe was highlighted in the final materials. The finding that consumers did not fully understand the table and consequently did not comprehend how nutrients and phytonutrients change postharvest was important and needed to be addressed in the final educational materials. The complexity of the table was confirmed by peer reviewers.

The educational materials were modified in response to data from the survey, consumers' suggestions during the interviews, and some concerns of the peer reviewers. Most negative comments resulted in a change to the materials; however, if only a single consumer suggested a change with which the investigators did not agree, no change was made. Table 3 includes a summary of changes made to the materials. An example of the final version of the Tomatoes card is presented in Figure 1, and final versions of all the educational materials can be viewed at <http://localfoods.osu.edu/maximizenutrients>. The finalized educational materials were distributed to farmers' markets throughout Ohio and to all 88 county Extension offices.

## Impacts

### *Impacts on Consumers*

The educational materials described herein can be used to educate consumers about how to maximize nutrients and phytonutrients from local produce by using effective storage, preservation, and consumption strategies. The information provided in the materials complements existing public health messages that encourage people to consume a wide variety of fruits and vegetables. The impacts of implementing these educational materials relate to (a) consumers' preferences about receiving nutrition information; (b) the importance of consumers' receiving nutrition information, in

particular information about nutrients and phytonutrients; and (c) long-term effects of consumers' receiving such nutrition information:

- It has been shown that consumers have interest in receiving nutrition information at the time of purchase (Glanz, Hewitt, & Rudd, 1992), such as when purchasing fresh produce from a farmers' market.
- Dietary intake of consumers has been shown to be influenced by nutrition education (Barreiro-Hurlé, Gracia, & de Magistris, 2010; Verbeke, 2008). Moreover, consumption of fruits and vegetables has been associated with reduced risk of several inflammation- and age-related chronic diseases (Boeing et al., 2012; Holt et al., 2009; Hung et al., 2004), and adequate fruit and vegetable intake is becoming increasingly important as the population ages and chronic diseases become more prevalent. It is generally thought that phytonutrients may be at least partially responsible for the protective effect caused by consumption of fruits and vegetables. An understanding of best practices for storage, preservation, and consumption of fruits and vegetables can, therefore, help consumers maximize their consumption of nutrients and phytonutrients, thus maximizing associated health benefits.
- Although the immediate goal of the study reported here was to increase consumer awareness of best practices for storage, preservation, and consumption of fruits and vegetables, longer term, this increased awareness could influence local food purchase decisions, improve dietary patterns, increase nutrient/phytonutrient delivery, and increase consumers' ability to use local fruits and vegetables for a greater portion of the year through the use of more efficient storage options.

Although not representative of all consumers, our sample cohort may be applicable to other farmers' market consumer cohorts with similar demographics (educated, employed).

## ***Implications for Extension***

The methodology used in the study described here has implications for wider use within Extension. A previous study demonstrated that a particular cohort of farmers' market consumers had an interest in the topic of nutrient retention in produce but lacked knowledge on how to maintain nutrient and phytonutrient levels when storing, preserving, and consuming produce (Remley et al., 2015). Results from the study were useful when developing the materials for our study because they could be targeted toward the appropriate audience. In our study, testing the educational materials with a subset of the target population provided valuable content and format information, which was incorporated into the finalized materials. This two-tiered approach of first examining the intended audience in order to appropriately target the materials and then implementing a pilot use of the educational materials with the intended audience can be implemented by other Extension professionals and applied to educational materials developed for various audiences.

## **Conclusion**

In conclusion, the printed educational materials we developed were well accepted by farmers' market consumers and served to educate these consumers on the best practices for storing,

preserving, and consuming produce to maximize both health benefits and the use of local produce. The strategies we employed can be applied by other Extension professionals when developing educational materials for different audiences. Future work will include evaluation of the impact of the educational materials on consumer behavior related to purchase, storage, preservation, and consumption of local produce.

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