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Maximizing the Nutritional Value of Produce Post-Harvest: Consumer Knowledge Gaps, Interests, and Opinions Regarding Nutrition Education Strategies

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Maximizing the Nutritional Value of Produce Post-Harvest: Consumer Knowledge Gaps, Interests, and Opinions Regarding Nutrition Education Strategies

Abstract

Although many consumers perceive locally produced, fresh fruits and vegetables to be healthier, they might not have the knowledge and skills to retain optimal nutritional quality following harvest or purchase. We surveyed Ohio farmers market consumers' and managers' knowledge and interests related to maximizing nutritional value of produce. Consumers and managers lacked knowledge but were interested in the topic. Respondents were concerned about chronic health conditions and how foods and nutrients might prevent them. The perspectives and knowledge gaps of the target audience will assist the development of educational materials and strategies.

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Introduction

There is growing consumer interest in both fresh foods and locally produced fruits and vegetables, with a consequent increase in popularity of farmers markets, community supported agriculture programs, produce auctions, and other farm to table markets (Lerman, Schlack, & Austin, 2010). Research suggests that fruits and vegetables are nutrient dense, containing fiber, a variety of vitamins and minerals, and hundreds of bioactive phytonutrients that are thought to protect against type 2 diabetes, cardiovascular disease, and several types of cancers (United States Department of Agriculture, 2010). Often nutrient quality declines once produce is harvested, but nutrient loss and nutrient availability depend on the type of produce and methods used to preserve, store, prepare, and even consume it (Rickman, Barrett, & Bruhn, 2007; Rickman, Bruhn, & Barrett, 2007; U.S. Department of Agriculture, 2011). For example, lycopene found in tomatoes, suggested to be protective for prostate and other types of cancers, is more bioavailable if tomatoes are cooked or

canned, rather than consumed fresh (Gärtner, Stahl, & Sies, 1997; Porrini, Riso, & Testolin, 1998; Rickman, Barrett, et al., 2007; Rickman, Bruhn, et al., 2007; U.S. Department of Agriculture, 2011).

Although many consumers perceive locally produced, fresh produce to be healthier, they might not have the knowledge, awareness, and skills to retain optimal nutritional quality following harvest or purchase. As part of a larger social marketing project to educate consumers on the best ways to maximize the nutritional value of farmers market produce, we set out to assess farmers market consumers' and managers' knowledge gaps and interests in nutrient and phytonutrient changes in fresh and preserved produce and their opinions about educational materials and distribution strategies. Farmers markets were chosen because of their ability to make locally grown food available to consumers and provide a venue for health promotion activities (Parsons & Morales, 2013). Assessing knowledge gaps, interests, and opinions was important for our goal as Extension professionals to develop nutrition education materials and strategies relevant to our audience.

Methods

A short survey was developed by the researchers using the principles of social marketing theory, which considers an audiences' characteristics (demographics, knowledge levels, opinions), motivations (interests, health concerns), and barriers (access to information) towards desired behaviors (maximizing nutritional value of produce) (Grier & Bryant, 2005). Specifically, the survey consisted of 28 multiple choice questions that measured the consumers' knowledge of nutrient retention, interest in preserving foods and learning about nutrient retention, opinions on the format and type of information to be included on the educational materials, thoughts on strategies for distribution, and demographics (Table 1). Following a peer review by Extension colleagues, the survey was administered to a convenience sample of 54 volunteer consumers at three Ohio farmers markets visited in autumn 2012. Once completing the survey, participants received a \$5 voucher to be used at the farmers market. Using web-based Survey Monkey, the survey was also emailed and administered to farmers market managers but did not include demographic questions. The market managers' survey also had an added question related to distribution challenges at the farmers markets. The project was approved with exempt status by the Ohio State University's Institutional Review Board review.

Table 1.

Categories and Examples of Multiple Choice Questions Used

Category of questions	Examples
Assess current level of knowledge (respondents were asked to select one choice for each question)	Who is most likely to sell produce that was picked most recently? Over time, how does the amount of nutrients change in all fruits and vegetables? What is the best way to get the most vitamin C out of green peas? How does the antioxidant content change during raspberry storage in the grocery store and at home in the refrigerator? Which of the following should you eat with your tomatoes to get the most nutrients from the tomatoes?

<p>Assess motivations (respondents were asked to select multiple choices for each question)</p>	<p>Do you preserve (e.g. dry, can, freeze) fresh produce? Why do you preserve fresh produce? What information about nutrients would you most like to learn about? What health concerns most influence your food choices? Which statement best describes what you do to get the most nutrients from your fresh produce?</p>
<p>Aid development of the materials (respondents were allowed to select multiple choices for each question)</p>	<p>What format of nutrition informational materials related to local produce would you find most useful? What type of information should be included on nutrition informational materials related to local produce?</p>
<p>Identify appropriate distribution strategies (respondents were allowed to select multiple choices for each question)</p>	<p>Where would informational materials be most visible to farmers market shoppers? What types of printed nutrition informational materials related to local produce would you find easiest to distribute at a farmers market? (manager survey only) What would be the most difficult aspect about distributing educational materials at the farmers market? (manager survey only)</p>
<p>Demographic questions (Consumers only- respondents were asked to select one response for each question)</p>	<p>What is your gender? How old are you? Do you receive food assistance? What is your current employment status? What is the highest degree or level of school you have completed?</p>

Results

Demographics of Sample

Overall, 54 farmers market consumers and 49 farmers market managers completed the surveys. The

demographics of the farmers market consumers are shown in Table 2. The farmers market consumers were primarily female, aged 31-50 years, employed full-time, and held at least a Bachelor's degree. To maintain privacy, we did not collect demographic data on market managers. The markets that the managers oversaw had an average of 27 vendor booths, with a range of 2-100. Consumers and managers had similar responses, and so we decided to combine both groups in our analysis. In addition, we assumed that managers would also be likely to be consumers of farmers market produce.

Table 2.
Demographics of Farmers Market Consumers

Demographic Descriptor		Responses=54 (%)
Gender	Female	41 (75%)
Age	18-25 years	6 (11%)
	26-30 years	2 (4%)
	31-50 years	23 (42%)
	51-70 years	19 (36%)
	71 years	4 (8%)
Food Assistance	Receives assistance	4 (8%)
Employment Status	Full-time	26 (48%)
	Part-time	10 (19%)
	Retired	9 (17%)
	Unemployed	6 (11%)
	Other	2 (4%)
Education level	Some high school	1 (2%)
	High school degree or GED	4 (8%)
	Some college or 2-year degree	9 (17%)
	Bachelor's degree	16 (30%)
	Graduate or professional degree	23 (43%)

Current Use of Preservation Techniques

Farmers market consumers and managers had history and interest in preserving fresh produce. Most (65%) of the respondents had preserved fresh produce in the past year, but 23% had never preserved (12% had preserved but more than 1 year ago). Respondents indicated that their primary reason for preserving fresh produce was to allow consumption of local produce throughout the winter (60%). In addition, approximately 40-45% of respondents preserved to save money and control ingredients, 30-35% preserved to control food safety and increase fruit and vegetable intake, 25-30% preserved because it tastes better and allows the purchase of greater quantities of fresh produce, and because he/she is concerned about his/her family's health, and 20% preserved because he/she thought it was more nutritious.

Knowledge and Interest in Nutrient and Phytonutrient Retention

Respondents understood that food preservation can affect nutrient and phytonutrient retention, but greater than 75% of respondents did not understand that this change depends on the type of produce and the preservation technique. For example, 77% incorrectly assumed that tomatoes are healthier if eaten fresh rather than cooked. Respondents were generally interested in learning about nutrient retention in produce, with 78% interested in how to store produce, 71% interested in how to consume produce, and 66% interested in how to preserve produce to maximize nutrient and phytonutrient retention. They were also very interested in learning about which foods might prevent certain diseases (66%), followed by how nutrients may prevent certain diseases (54%), how foods might prevent certain disease (50%), the names of nutrients (50%), and which nutrients prevent certain diseases (50%). The health conditions respondents were most interested in were body weight (75%) and heart disease and stroke (53%). Only 30-40% of respondents were interested in diabetes, blood pressure, cancer, and lack of energy, and 23% were interested in osteoporosis.

Respondents' Opinions about Format and Distribution of Educational Materials

When asked about the format of the educational materials, approximately 70% of respondents preferred either a website or print materials. Less favorable options were regular emails (32%), social media (24%), mobile apps (15%), radio (13%), television (9%), and media advertisements (7%). Respondents suggested the content should include facts (93%), followed by recipes (68%) and links to additional resources (61%). For printed educational materials, there was a strong preference toward a 4 x 6 inch card (70%) rather than a magnet (36%), 8.5 x 11 inch paper handout (27%), sticker (24%), small paper spin wheel (22%), printed grocery bag (18%), or large poster (15%). Most respondents preferred educational materials to be available at individual vendor booths, followed by the market information booth. The market webpage was also a favorable option (55%), followed by the less favorable weekly market email (42%) and large poster display (29%).

Managers were specifically asked about the difficulties they foresaw in distributing the materials, and

90% of managers responded that weather or wind could pose an issue. Managers responded that storage during the week, bringing the materials each week, distributing to vendors, finding an appropriate location, and monitoring the distribution area were not difficulties they would face (25%).

Table 3.

Summary of Responses That Will Guide the Development of Educational Materials

Response (n=103 consumers and managers)	Interpretation
77% of consumers received at least a Bachelor's degree	Materials can be directed toward an educated audience.
65% of consumers and managers preserved fresh produce in the past year 66-78% of consumers and managers were interested in how to store produce, how to consume produce, and how to preserve produce to maximize nutrient and phytonutrient	This topic is of interest to our target consumer. There is value to developing educational materials.
75% of consumers and managers did not understand that nutrient and phytonutrient changes depend on the type of produce and type of preservation	There is a knowledge gap and value to developing educational materials to fill this gap.
66% of consumers and managers were interested in learning about which foods might prevent certain diseases 54% interested in how nutrients may prevent certain diseases	Content of materials should be focused on foods rather than nutrients.
53-75% of consumers and managers interested in body weight, heart disease and stroke	Content should focus on body weight, heart disease and stroke, rather than diabetes, blood pressure, cancer, energy and osteoporosis.
70% of consumers and managers preferred either a website or print materials	Materials will be both printed and posted on a website.
60-93% of consumers and managers responded that the content should include facts, recipes, or links to additional resources	Facts, recipes, and links to additional resources will be provided in the materials.
70% of consumers and managers preferred a 4x6 postcard for the printed material, rather than the	The printed materials will be developed for a 4x6

other options presented	postcard.
68% of consumers and managers preferred distribution through individual vendors 59% of consumers and managers preferred distribution through the market information booth	Consumer preference was stronger for the vendors rather than the information booth. Materials will be distributed through vendors.
90% of managers responded that weather and/or wind would be a challenge	Materials will be printed on card stock and a plastic container will be provided.

Discussion

The data generated in the study reported here will be used to guide development of educational materials related to nutrient and phytonutrient retention in produce. Nutrition education is known to influence consumers' choice of dietary intake (Barreiro-Hurlé, Gracia, & de-Magistris, 2010), and others have found that consumers are interested in receiving nutrition information at the time of purchase (Glanz, Hewitt, & Rudd, 1992). Our farmers market sample, although not necessarily representative, provided insights for our larger social marketing project and might provide insights for future educational endeavors at farmers markets. Consuming fruits and vegetables is suggested to be beneficial to prevent many inflammation- and age-related chronic diseases (Boeing et al., 2012; Holt et al., 2009; Hung et al., 2004). Those who are especially at risk or managing diabetes, cancer, or heart disease should consider how produce is stored, preserved, prepared, and even consumed to maximize nutrient retention and bioavailability. Our consumer sample was late middle aged, generally had a high level of education, was health conscious, and was interested in strategies to maximize the nutritional value of produce post-harvest. Many already had experience with at least some form of preservation method, and indicated that they preserve at least once a year.

Our results also suggest that there is a knowledge gap in terms of people not understanding how nutrient and phytonutrient levels in produce can be impacted post-harvest. Others have also found consumers to have misconceptions of nutrition knowledge (Dickson-Spillmann & Siegrist, 2011).

Respondents offered opinions related to educational materials and strategies. Table 3 shows opinions about educational strategies and our interpretation for the next step of material development. Our respondents preferred to obtain their information via the Internet or via printed materials, but preferred limited information about which foods affect health, rather than the mechanisms behind *how* foods and their nutrients affect health. Internet links, Quick Response (QR) Codes, and recipes were popular ideas for printed materials. Consumers thought that the ideal way to distribute materials was through individual vendors at farmers markets. Managers suggested that weather and wind could be a challenge for distribution of materials.

Conclusion

Considering our aging population, and that many manage or are concerned about chronic diseases, maximizing the nutritional value of produce might be an emerging focus in terms of nutrition education and promotion. Primary public health strategy has focused on promoting the consumption of fruits and vegetables to achieve dietary guidelines. We do not recommend changing this strategy, because consuming fruits and vegetables, whatever their forms, provides many health benefits. Educational materials related to maximizing the nutritional value of produce is warranted and would be most relevant to those who might be at risk for or are managing a chronic condition such as heart disease or cancer and are motivated to learn and adopt storage, preservation, and preparation strategies to protect their health. Finally, learners' self-efficacy to undertake a particular behavior is enhanced when learners are exposed to modeling or demonstrations (Bandura, 1998). Therefore, Extension nutrition workshops at farmers markets could demonstrate preservation or preparation techniques in order to help consumers become more efficacious with the produce that they have purchased. Farmers market programs also provide the opportunity to reach an audience that may not be aware of Extension and its related educational activities (Burrows, 2008).

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References

- Bandura, A. (1998). Health promotion from the perspective of social cognitive theory. *Psychology & Health*, 13(4), 623–649. doi:10.1080/08870449808407422
- Barreiro-Hurlé, J., Gracia, A., & de-Magistris, T. (2010). Does nutrition information on food products lead to healthier food choices? *Food Policy*, 35(3), 221–229. doi:10.1016/j.foodpol.2009.12.006
- Boeing, H., Bechthold, A., Bub, A., Ellinger, S., Haller, D., Kroke, A., ... Watzl, B. (2012). Critical review: vegetables and fruit in the prevention of chronic diseases. *European Journal of Nutrition*, 51(6), 637–63. doi:10.1007/s00394-012-0380-y
- Dickson-Spillmann, M., & Siegrist, M. (2011). Consumers' knowledge of healthy diets and its correlation with dietary behaviour. *Journal of Human Nutrition and Dietetics: The Official Journal of the British Dietetic Association*, 24(1), 54–60. doi:10.1111/j.1365-277X.2010.01124.x
- Gärtner, C., Stahl, W., & Sies, H. (1997). Lycopene is more bioavailable from tomato paste than from fresh tomatoes. *The American Journal of Clinical Nutrition*, 66(1), 116–122.
- Glanz, K., Hewitt, A. M., & Rudd, J. (1992). Consumer behavior and nutrition education: An integrative review. *Journal of Nutrition Education*, 24(5), 267–277. doi:10.1016/S0022-3182(12)81244-1.
- Grier, S., & Bryant, C. A. (2005). Social marketing in public health. *Annual Review of Public Health*, 26, 319–339. doi:10.1146/annurev.publhealth.26.021304.144610.
- Holt, E. M., Steffen, L. M., Moran, A., Basu, S., Steinberger, J., Ross, J. a, ... Sinaiko, A. R. (2009). Fruit and vegetable consumption and its relation to markers of inflammation and oxidative stress in

adolescents. *Journal of the American Dietetic Association*, 109(3), 414–21.
doi:10.1016/j.jada.2008.11.036.

Hung, H.-C., Joshipura, K. J., Jiang, R., Hu, F. B., Hunter, D., Smith-Warner, S. a, ... Willett, W. C. (2004). Fruit and vegetable intake and risk of major chronic disease. *Journal of the National Cancer Institute*, 96(21), 1577–84. doi:10.1093/jnci/djh296.

Lerman, K., Schlack, J. W., & Austin, M. (2010). Local eyes: The newly focused consumer lens. *Communispace*. Retrieved from: http://www.communispace.com/uploadedFiles/ResearchInsights/Research_Patterns/MacroTrends_LocalEyes.pdf

Porrini, M., Riso, P., & Testolin, G. (1998). Absorption of lycopene from single or daily portions of raw and processed tomato. *The British journal of nutrition* (Vol. 80, pp. 353–361).
doi:10.1079/096582198388300

Rickman, J. C., Barrett, D. M., & Bruhn, C. M. (2007). Nutritional comparison of fresh , frozen and canned fruits and vegetables. Part 1 . Vitamins C and B and phenolic compounds, *Journal of the Science of Food and Agriculture*, 944(December 2006), 87: 930–944. doi:10.1002/jsfa

Rickman, J. C., Bruhn, C. M., & Barrett, D. M. (2007). Nutritional comparison of fresh, frozen, and canned fruits and vegetables II. Vitamin A and carotenoids, vitamin E, minerals and fiber. *Journal of the Science of Food and Agriculture*. 87: 1185-1196. doi:10.1002/jsfa.2824

U.S. Department of Agriculture, A. R. S. (2011). No Title. Retrieved from:
<http://www.ars.usda.gov/ba/bhnrc/ndl>.

United States Department of Agriculture. (2010). No Title. Retrieved from:
<http://www.health.gov/dietaryguidelines/>.

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