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PROMOTION OF FRUIT AND VEGETABLE INTAKE THROUGH RECIPE CARD DISTRIBUTION AND SAMPLING AT FARMERS' MARKETS THROUGHOUT KENTUCKY

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THESIS

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science in Nutrition and Food Systems in the
College of Agriculture, Food and Environment
at the University of Kentucky

By

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ABSTRACT OF THESIS

PROMOTION OF FRUIT AND VEGETABLE INTAKE THROUGH RECIPE CARD DISTRIBUTION AND SAMPLING AT FARMERS' MARKETS THROUGHOUT KENTUCKY

The Center for Disease Control and Prevention (CDC) reports indicate that 8% and 6.3% of Kentuckians consume enough fruits and vegetables, respectively. The *Plate It Up! Kentucky Proud* (PIUKP) project is a recipe-development project that aims to boost produce consumption by incorporating local fruits and vegetables. The purpose of this study was to implement promotional strategies using PIUKP recipes at farmers' markets and determine their effects on consumers' intent of purchasing and preparing the produce. The study was conducted at nine farmers' markets across Kentucky (n=300) in collaboration with Cooperative Extension agents/assistants.

The consumers' impression of the sample was positively associated with their intent to purchase fruits and vegetables the same day ($t = 0.36$; $p<0.0001$), in future ($t=0.43$; $p<0.0001$), and prepare the respective recipes ($t=0.51$; $p<0.0001$). Distribution of recipe cards was also positively correlated with consumers' intent to prepare recipes ($t=0.35$; $p<0.0001$). However, no significant association was found between the self-reported fruit and vegetable intake and their respective dermal carotenoid score.

Findings from this study support the use of promotional strategies as a means to influence produce intake among farmers' market consumers. Future studies can apply these strategies and explore the extent of effect they have on dietary intake.

KEYWORDS: Farmers' Markets, Fruits and Vegetables, Promotional Strategies, Recipe Sampling, Dermal Carotenoid Scanner, Kentucky

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1. INTRODUCTION

Background

Consumption of a variety of fruits and vegetables has been shown to offer numerous health benefits (Oyebode, Gordon-Dseagu, Walker, Mindell 2014; Connor, Brookie, Carr, Mainvil, Vissers 2017). The *2015-2020 Dietary Guidelines for Americans* recommends that Americans consume at least five daily servings of fruits and vegetables to reduce the risk of chronic lifestyle diseases such as obesity, type 2 diabetes, and cardiovascular disease (USDHHS, USDA). However, according to recent statistics from the Centers for Disease Control and Prevention (CDC), adults across the United States exhibit an overall low consumption of fruits and vegetables (Lee-Kwan, Moore, Blanck, Harris, & Galuska, 2017).

One of the on-going strategies to address this low intake is the implementation of the *Plate It Up! Kentucky Proud (PIUKP)* project at the farmers' markets across Kentucky. Use of social marketing campaigns, such as PIUKP, has been found to be effective in improving produce intake of adult consumers (DeWitt, McGladrey, Liu, Peritore, Webber, Butterworth et al 2017). Likewise, food sampling is an important promotional tool; researchers suggest that an enjoyable sampling experience leads to direct-purchase of a commodity, followed by increased positive publicity (Chen, Parcell, & Moreland, 2016).

In terms of evaluating fruit and vegetable consumption, the traditional tools for dietary assessment are food diaries, 24-hour dietary recalls, and food frequency questionnaires, which rely on participants' memory and knowledge of portion sizes. Because of this, there is risk of misreporting or misinterpreting one's intake of fruits and vegetables (Lee-Kwan et al 2017). As such, accuracy of data can be increased by

supplementing a dietary assessment tool with a biomarker of fruit and vegetable consumption (Freedman, Kipnis, Schatzkin, Tasevska, & Potischman, 2010). Several studies have also measured blood levels of total carotenoids as a marker of fruit and vegetable intake (Conner, Brookie, Mainvil, Carr, Vissers, 2017). Based on the evidence that levels of carotenoids in skin correspond with blood carotenoid concentrations (Stahl et al. 2000), non-invasive instruments programmed with Raman Resonance Spectroscopy (RRS) detection techniques have been developed to measure dermal carotenoid levels (Ermakov, Gellermann 2012). Several studies report the use of RRS technique as a valid, feasible non-invasive method to determine dermal carotenoids as a health biomarker (Mayne et al. 2010, Beccarelli et al. 2017).

Problem Statement

Studies have consistently reported low rates of fruit and vegetable consumption amongst adults in the United States, particularly in Kentucky. Implementation of promotional strategies in retail stores has been shown to influence purchasing habits among consumers. However, such promotional efforts have not been evaluated as extensively at farmers' markets. For much of the research that has been done at farmers' markets, the researchers have relied on self-reported intake of fruits and vegetables, which may not accurately reflect true consumption patterns.

The purpose of this study was to implement promotional strategies, such as recipe sampling and distribution of recipe cards at farmers' markets and determine their effects on consumer purchasing habits of fruits and vegetables and ultimately on their intake. In

addition to this, a primary exploratory objective of this research was to study the correlation between self-reported fruit and vegetable intake and dermal carotenoid levels.

Research Questions:

1. Does sampling of PIUKP recipes influence purchasing habits of consumers at farmers' markets throughout Kentucky, particularly among those with low FV intake?
2. Does distribution of PIUKP recipe cards increase consumers' likelihood to prepare the recipes?
3. In what way does the consumers' past fruit and vegetable intake drive their sampling and taking of recipe cards at the farmers' market?
4. How does self-reported intake of carotenoid-rich fruits and vegetables correlate with dermal carotenoid scores, obtained using the Veggie Meter?

Hypotheses:

1. Sampling of PIUKP recipes at farmers' markets throughout Kentucky positively influences the purchasing habits of consumers.
2. Distribution of PIUKP recipe cards at farmers' markets increases the likelihood consumers will prepare the recipe.
3. Consumers' past fruit and vegetable intake is associated with their experience of trying new samples and taking recipe cards at the farmers' market.
4. Self-reported intake of carotenoid-rich fruits and vegetables relates closely with the dermal carotenoid scores obtained using the Veggie Meter.

CHAPTER 2. LITERATURE REVIEW

Introduction

Recent research has shown that owing to their rich nutrient composition, consumption of a variety of fruits and vegetables offers numerous physiological (Oyebode, Gordon-Dseagu, Walker, Mindell 2014) and psychological benefits (Connor, Brookie, Carr, Mainvil, Vissers (2017). Intake of fresh produce, particularly vegetables, has been associated with low risk of mortality from cancer, cardiovascular problems (Oyebode et al. 2014) and obesity (Slavin, Lloyd 2012). Fruits and vegetables form an integral part of the diet as they provide vitamins, minerals and dietary fiber that offer protective benefits to health (Slavin, Lloyd 2012). The *2015-2020 Dietary Guidelines for Americans* recommend that Americans should consume sufficient amounts of fruits and vegetables to prevent and reduce the risk of chronic lifestyle diseases (USDHHS - USDA). However, according to recent statistics by the Centers for Disease Control and Prevention (CDC), adults across the United States have an overall low consumption of fruits and vegetables (Lee-Kwan, Moore, Blanck, Harris, & Galuska, 2017). In particular, adults in Kentucky have a reported median intake of 1 fruit daily and median intake of 1.5 vegetables daily. As a result, only 8% of the adults in Kentucky appear to meet the recommended intake of fruit, while a mere 6.3% meet the vegetable intake recommendations (Lee-Kwan et al 2017). The Division of Nutrition, Physical Activity, and Obesity (DNPAO) at the CDC offers guidance to increase access, availability, and affordability of fruits and vegetables. One of the guidance strategies is the establishment and promotion of farmers' markets in communities.

A systematic review published in the *Journal of the Academy of Nutrition and Dietetics* (2016) spanned over twenty years of literature from 1994-2014. The review

examined the factors influencing overall use of farmers' markets with special focus on low-income populations. Researchers found that one of the major barriers consistently reported among low-income consumers was the perception regarding food assistance benefits that they were not accepted. As for the consumers belonging to middle, high, and non-specified income categories, food variety at farmers' markets was a facilitator for many, but also a barrier among a significant number of participants who believed the markets offered limited food variety. Researchers suggested that the results of this review offered direction to target these consumer misconceptions by implementing practices to promote intake of a variety of fruits and vegetables and increase consumers' exposure at farmers' markets (Freedman, Vaudrin, Schneider, Trapi, Ohri-Vachaspati, Taggart, Cascio, Walsh & Flocke 2016).

Farmers' Markets and Their Relation to Fruit and Vegetable Intake

According to the Farmers' Market Promotion Program 2016 Report, the number of farmers' markets across the U.S. has dramatically increased by 394% in the last two decades, from 1755 markets in 1994 to 8687 markets in 2016. The USDA market manager survey showed that 60% of items that market farmers sell include fresh fruits, vegetables, flowers and herbs (Ragland, Tropp 2009). This staggering four-fold increase in the number of farmers' markets offers greater opportunity for consumers to access and purchase fresh, locally grown produce.

As farmers' markets constitute a major resource for obtaining quality produce, researchers have studied their influence on consumption of fruits and vegetables among the farmers' market consumers. Pitts and colleagues (2014) conducted a 5-month study

among rural communities with low access to fruits and vegetables. They evaluated the presence of associations between access to farmers' markets, its awareness, and use, with fruit and vegetable intake and body mass index (BMI). Although no relationship with BMI was found, researchers indicated that intake of fruits and vegetables was positively associated with shopping at the farmers' market. (Pitts, Gustafson, Qu, Mayo, Ward, McGuirt and Ammerman 2014).

Similarly, McCormack et al (2010) conducted a systematic review of sixteen articles that focused on effect of farmers' markets and community supported agriculture (CSA) gardens on nutrition-related outcomes with respect to fruit and vegetable intake, intake of other foods/beverages, food insecurity, attitudes and beliefs regarding buying, preparing and consuming fruits and vegetables, and perceptions of receiving produce from the two sources (McCormack, Laska, Larson, & Story, 2010). Ten out of the 16 articles included in the review assessed fruit and vegetable intake and included seniors and low-income women enrolled in nutrition incentive programs. Findings of the review revealed that six studies reported higher intake of fruits and vegetables in consumers participating in a farmers' market program. Moreover, three articles provided evidence of an association between farmers' markets and increased vegetable, but not fruit, intake. One study reported an overall increase in produce consumption in consumers participating in the farmers' market nutrition program. Furthermore, studies that assessed their attitudes and beliefs regarding buying, preparing and eating fresh produce, found that women participants were more likely to prepare and consume fruits and vegetables. This review gave insight on the significance of farmers' market programs, which greatly influences behaviors and perceptions regarding fruit and vegetable intake.

Similarly, participants of a bonus incentive program at 22 farmers' markets in Philadelphia, Pennsylvania, reported an increased consumption of fruits and vegetables following…(Young et al., 2013). Enrolled in the Philly Food Bucks program for a period of 3 months, the participants, who belonged to low-income neighborhoods, were assessed once for change in their dietary behavior pertaining to change in their fruit and vegetable consumption as well as willingness to try new fruits and vegetables. The survey revealed positive results indicating successful use of a farmers' market nutrition program for increasing intake of fruits and vegetables (Young, Aquilante, Solomon, Colby, Kawinzi, Uy, Mallya 2013). Likewise, several studies recognize the role of farmers' markets associated with higher intake of fruits and vegetables (Racine, Vaughn, & Laditka, 2010), (Grin, Gayle, Saravia, & Sanders, 2013), (Strome, Johns, Scicchitano, & Shelnutt, 2016).

A recent study by Bryce et al (2017) explored the role of a farmers' market-based fruit and vegetable prescription program called the *Fresh Prescription*, conducted over a period of thirteen weeks in Detroit, MI. The program was administered by a federally qualified health center and was targeted toward an audience of adult patients belonging to low income background who were diagnosed with uncontrolled type 2 diabetes. Through this prescription program, participants were provided with an incentive of $10 per week for four weeks if they regularly filled their prescriptions of fresh produce at the designated farmers' markets. At the end of the four-week study period, participant HbA1C levels were significantly reduced by 0.5%. The study highlighted the potential of regular attendance at the farmers' market with regards to produce intake and eventually its effect on health (Bryce, Guajardo, Ilarraza, Milgrom, Pike, Savoie, Valbuena & Miller-Matero, 2017).

Nutritional Promotion at Farmers' Markets

Promotion of the farmers' markets was listed as one of the top two scenarios to encourage farmers' market shopping (Jilcott et al. 2014). Eighty-six percent of the markets that were sponsored by the Farmers' Market Promotion Program reported success as they held food tastings and other youth activities (USDA AMS 2017). Further highlights of the program success included encouraging healthy dietary habits by disseminating nutrition education, conducting health screenings and/or cooking demonstrations with healthy foods.

Chen and his colleagues (2016) evaluated the factors that drive consumer preference with regards to sampling of food. Using online surveys, they investigated why consumers were prone to either taste or reject a food sample, and studied their behavior, perception and likelihood of purchasing the product. Results indicated that consumers accepted samples more from those vendors who were friendly, well-trained and certified. Furthermore, willingness of consumers to try free samples was associated with the level of trust they had with the vendor. The latter was found to be influenced by the quality of, and knowledge about, the sampled food. Interestingly, the major negative factor that was reported for rejecting a sample was the pressure faced by the consumer for having to buy the product after sample-tasting. Therefore, food sampling is an important promotional tool as researchers concluded that an enjoyable sampling experience leads to direct-purchase of a commodity, followed by increased positive publicity. Moreover, friendliness of a vendor was regarded as a factor that greatly influenced sampling experience (Chen, Parcell, & Moreland, 2016).

Another way of incentivizing is derived from the methods of behavioral economics which is a blend of psychological insights with the economic decision-making process. According to a meta-analysis of financial incentives (Haff, Patel, Lim, Zhu, Troxel, and Asch 2015), "behavioral economics is a promising field of study that leverages individuals' tendencies to be predictably irrational to design interventions that change behavior". From a health behavior perspective, it entails the provision of financial incentives in the form of conditional payments to be rewarded if the behavior change is achieved. Thus, to facilitate a positive change in people's health behavior through better shopping habits and adjusting the food environment, Kral et al (2016) applied this approach to increase fruit and vegetable intake among adults in Philadelphia. In a cross-sectional randomized controlled trial, study participants received $1 for every healthy food item they bought. This included purchasing fruits and vegetables among other groceries like low-fat dairy and low/no-calorie beverages. Within a span of 3 months, receiving the financial incentive resulted in increased purchase and therefore consumption of a relatively higher quantity of healthy foods. Studying the participants' food records during follow-up visits, researchers observed a significant increase in the intake of particularly vegetables ($p<0.02$) from just a little over a single serving at baseline to more than two servings in the third month of intervention. There was also a positive improvement in their home environments as evident by the food inventories when compared to the control group who received no incentive (Kral, Bannon, & Moore, 2016).

Incentive programs at farmers' markets encourage people to consume more fruits and vegetables. A study published by the University of Illinois College of Agriculture, Consumer and Environmental Sciences (UIACES 2013) highlighted the use of vouchers

among mothers enrolled in the Women, Infant and Child (WIC) program. When provided with farmers' market vouchers, 57% of the 377 participants increased their consumption of fruits and vegetables and were more likely to choose produce options as snacks.

Furthermore, a nationwide study (2013) called the *SNAP Healthy Food Incentives Cluster Evaluation* was conducted over a period of two years to study the effect of various provisions of incentives and vouchers among low income communities, especially focusing on the recipients of Supplemental Nutritional Assistance Program (SNAP) at farmers' markets. Results from the report reveal that healthy food incentive programs boost purchase and consumption of locally grown fruits and vegetables. In addition to improving their dietary habits, the new customer base acts as a vehicle in increasing the economic benefit for the local farmers, thereby giving the program a multifold benefit (Community Science 2013).

Another aspect of increasing produce intake among consumers, besides incentive programs, is educational-cum-promotional programs. One such program that addresses poor consumption rates of fruits and vegetables is the *PIUKP* program in the state of Kentucky (University of Kentucky, 2016). PIUKP is an on-going partnership project between the University of Kentucky Cooperative Extension Service, the Kentucky Department of Agriculture, and the University of Kentucky Department of Dietetics and Human Nutrition. Since its inception in 2009, the objective of PIUKP has been to increase consumer purchase, preparation, and preservation of locally grown seasonal commodities (UK 2016). The program has been implemented at the farmers' markets across the state of Kentucky, providing samples and recipe cards to increase consumer knowledge of locally grown produce and healthy recipes incorporating local fruits and vegetables (Liu,

Stephenson, Houlihan, Gustafson 2017) (DeWitt, McGladrey, Liu, Peritore, Webber, Butterworth et al 2017).

Not only that but in order to improve produce purchase, researchers applied marketing strategies like promotional discounts on fruits and vegetables, food samples, recipe cards (Liu et al 2017) and tote bags along with gas cards, to address the travel barrier (DeWitt et al 2017), were provided as interventions at the grocery stores and farmers' markets respectively. These strategies were associated with increased consumption of fruits and vegetables. The community-based marketing program led by DeWitt et al was implemented for a period of two years at six farmers' markets in the rural counties of Kentucky. They found that the program possibly influenced shoppers' purchasing habits along with significantly influencing their willingness to prepare the sampled recipes at home (DeWitt et al 2017).

Dietary Assessment Methods

Although above studies have stated increased intake of fruits and vegetables among certain populations of adults, statistical studies consistently report overall low consumption of fruits and vegetables, dropping to as low as only 1 in 10 adults meeting their daily recommendations (Lee-Kwan, Moore, Blanck, Harris, & Galuska, 2017). According to the State Indicator Report on Fruits and Vegetables 2013 (CDC 2013), only 3 states report a median consumption of ≥ 1.8 serving of fruits and vegetables per day. After correcting for possible reasons for such low statistics like decreased access, affordability, and availability of fruits and vegetables (Young et al., 2013) (Leone et al., 2012) and probing further into

the problem, researchers considered comparing the methods of dietary assessment (Park et al., 2018).

2.1.1 Self-reported Dietary Assessment Methods

Traditional tools used for dietary assessment are food diaries or food records, 24-hour dietary recalls, and food frequency questionnaires, which rely on participants' memory and knowledge of portion sizes (Willett, 2012). Validated survey tools, such as the National Cancer Institute 17-item Multifactor Screener (Racine et al., 2010), interviewer-administered survey (Grin et al., 2013), face-to-face interviews (Young et al., 2013), fruit and vegetable screener.

When Young et al (2013) determined the association of farmers' market use and fruit and vegetable intake, one of the limitations highlighted in the study was the possible inaccuracy of dietary intake because the method implemented for dietary assessment was based on self-reported intake (Young et al., 2013). Similar is the case with numerous studies (Pitts et al., 2014) (Al-Otaibi 2014) where data is assessed based on self-reported survey tools. As with any self-reporting tool, there is a risk of misreporting intake of fruits and vegetables (Lee-Kwan et al., 2017).

2.1.2 Biomarker Assessment:

Park et al (2018) conducted a 12-month study among four groups of older adults aged 50-74 years, with the aim of comparing their dietary intakes. The researchers collected information on dietary intake using the three self-reporting assessment methods, i.e., food records (DFRs), Automated Self-administered 24-hour dietary recalls (ASA24S), and food-frequency questionnaires (FFQs). This self-reported data was measured against

recovery biomarkers, the information to which was collected in 24-hour urine samples (containing biomarkers for protein, potassium and sodium) and by administration of doubly labeled water (gold standard biomarker for energy intake). Researchers found that participants severely under-reported their dietary intakes, especially on the FFQs. Although biomarker assessment was the most accurate method to determine dietary intake, ASA24S was regarded as the most reliable tool for dietary assessment amongst the three self-reported methods (Park et al., 2018).

Therefore, In order to increase the accuracy of data collected from self-reporting methods, a dietary assessment tool can be supplemented with a biomarker (Freedman, Kipnis, Schatzkin, Tasevska, & Potischman, 2010) (Park et al., 2018).

Researchers at Queen's University, UK, conducted a systematic review of 96 studies to evaluate the most accurate biomarkers of fruit and vegetable intake. Results showed that plasma and serum carotenoids and vitamin C were the most consistently responsive with intake of fruits and vegetables, emphasizing their role as the most accurate biomarkers of FV intake (Jansen, Van Kappel, OckE, Van't, Boshuizen, Riboli, Bueno-de-Mesquita 2004) (Baldrick, Woodside, Elborn, Young, & McKinley, 2011). Furthermore, in a report by Jansen and colleagues (2004), total plasma carotenoids and beta-cryptoxanthin were found to be the best indicators of fruit consumption, while lycopene levels mirrored vegetable intake (Jansen, Van Kappel, OckE, Van't, Boshuizen, Riboli, Bueno-de-Mesquita 2004). Using this knowledge, several studies have measured blood levels of total carotenoids and vitamin C as a marker of fruit and vegetable intake among both adults and children alike (Baldrick, Woodside, Elborn, Yound, McKinley 2011)

(Souverein, Vries, Freese, Watzl 2015) (Cooper et al 2015) (Conner, Brookie, Mainvil, Carr, Vissers, 2017).

2.1.3 Dermal Carotenoids

Although evaluating dietary intake of FV using biological specimens such as blood and urine can be an accurate method of determining produce consumption (Baldrick et al 2011), non-invasive techniques to measure carotenoid levels have become more commonly used in research trials. Based on the evidence that levels of carotenoids in skin correspond with blood carotenoid concentrations (Stahl et al. 2000), instruments programmed with Raman Resonance Spectroscopy (RRS) detection technique have been developed to measure dermal carotenoid levels (Ermakov, Gellermann 2012) as it serves as the optical measure for carotenoid content (Mayne et al., 2013).

RRS is a type of laser spectroscopy and uses light-scattering technique for detection of molecules based on their vibrational/rotational energy (Mayne et al., 2013). The carotenoid molecules, in particular, are best suited for detection via RRS owing to their conjugated carbon-backbone molecular structure. This structure allows the molecules to be strongly absorbed in the blue wavelength region, which thereby provides the basis for resonant laser excitation of the molecules with visible laser lines. However, carotenoid species vary in their structure, but their respective stretch vibration frequencies can be detected with RRS, where they appear in the form of "*sharp spectral lines*" which are shifted by the vibrational frequencies relative to that of the laser's. When researchers studied the reproducibility of carotenoids in the body, they found that the highest concentration of carotenoids was present in the forehead, palm of the hand and sole of the

foot. The RRS detection technique, involving the use of a device, called a raman detector, was used to measure carotenoid levels on the exposed part of the palm of the hand as it was a convenient site (Ermakov, Sharifzadeh, Ermakova, Gellermann 2005).

Based on the palm studies, Mayne et al (2013) studied the highest reproducibility of carotenoids across different body sites - the palm, inner forearm and outer forearm. After testing at six different points of time, the researchers concluded that the concentration of carotenoids was consistently high each time in the palm of the hand as compared to the other sites.

Several studies further assessed skin carotenoid levels in both school and college students and have reported the use of RRS technique as a valid, feasible non-invasive method to determine dermal carotenoids as a health biomarker (Mayne et al. 2010, Beccarelli et al. 2017). Therefore, using reflection spectroscopy, RRS instruments can be successfully used to measure dermal carotenoid levels (Ermakov, Gellermann 2012), which are useful to assess produce consumption and indicate overall health status (Beccarelli et al. 2016).

Summary

Improving fruit and vegetable intake in the community is one of the major objectives of health promotion programs. Based on the extensive literature, use of farmers' market promotional activities is strongly correlated with the consumption of fruits and vegetables among all populations irrespective of economic status. Implementation of practical promotional strategies at farmers' markets to aid in increasing produce intake needs to be

further investigated. Moreover, overall low intake of fruits and vegetables by consumers can be attributed to multiple factors, including cost and lack of availability. As previously discussed, multiple studies have recommended implementation of stronger study designs and valid, reliable, and widely accepted dietary assessment methods. In addition, use of biomarkers for FV consumption appears to be useful and accurate in conjunction with standard dietary assessment methods.

CHAPTER 3. METHODOLOGY

The research protocol for this study, bearing application number #44639, was submitted to the University of Kentucky Institutional Review Board (UK IRB) which was approved prior to the data collection period. The IRB Approval letter and the Stamped Informed Consent form are attached as Appendix 1 and Appendix 2 respectively.

Study Design

This was a cross-sectional study, that was carried out over a period of three months and was conducted at the farmers' markets in nine counties throughout Kentucky. The study, in collaboration with the Family and Consumer Sciences (FCS) County Cooperative Extension Offices, began in June 2018 and ran through August 2018. Participation in the study was voluntary and open to all adults ages 18 years and older at the participating farmers' markets. Interested subjects were asked to take a brief survey after being provided with a PIUKP recipe sample and recipe card. As well, dermal carotenoid levels were measured via a Raman Resonance Spectroscopy (RRS) carotenoid scanner. The first set of surveys and dermal carotenoid assessments was conducted in June 2018 and the final set in August 2018. The participant time commitment was no more than 10 minutes in total. The study included a $10 gift card incentive for study participation.

3.1.1 Research Procedure

As part of the PIUKP project, a mass email was sent out to FCS agents in different Kentucky counties to share updates regarding their recipe sampling plan at the farmers' markets. Out of those contacted, agents from eleven counties responded positive to the

sampling plan. The principal investigator coordinated with them and was able to schedule for nine visits until the target sample size was achieved (n=300). The study sites were only chosen based upon the sampling plans of the FCS agents/assistants. The study was conducted over a three-month period during the summer months of June through August 2018. On days of sampling, the study personnel traveled to the participating county's farmers' market carrying recipe cards, survey tools, the dermal carotenoid scanner kit and $10 Amazon gift cards according to an estimated number of turn-out given by the agent/assistant. An average of 3 hours was spent at each market.

A booth was set up to display the PIUKP sample that were selected and prepared by the FCS Extension agent and consumers at the market were invited to taste the sample(s) and participate in the study. After obtaining informed consent from interested participants, subjects were asked to taste the displayed sample (one of the many belonging of the PIUKP recipe collection) prepared by the FCS Extension agents. They also received the PIUKP recipe card(s) for the sampled recipe(s). Each market offered one PIUKP sample to taste except at Montgomery where two PIUKP recipe samples were presented.

Next, participants were asked to complete a combination of two surveys that focused on, but were not limited to, the average fruit and vegetable intake over the past one month. The initial survey also included questions on evaluating the sample tasted, their shopping habits at farmers' market, and contribution of recipe cards and sampling in meal preparation. Subsequently, dermal carotenoid levels were measured using the RRS-based carotenoid scanner called as the "Veggie Meter." Participants were asked to place their index finger, after cleaning with an alcohol strip, in the Veggie Meter for 20 seconds to

detect their dermal carotenoid concentrations. At the end of the assessment and surveys, participants were compensated for their time with a $10 Amazon gift card.

Participants

Study personnel conducted on-site recruitment, which began on the day of recipe sampling at the farmers' markets. The study was open to all adults (18 years or older) at the participating farmers' markets, irrespective of their gender and ethnic background. Participants with food allergies and/or specific dietary restrictions with respect to the displayed recipe sample were excluded from the study. A total of 300 participants were enrolled for the study during the three-month period.

Measurements:

The study used a two-page hard copy survey tool, including a FFQ based on two validated surveys. The survey took approximately 5 minutes to complete. As well, a non-invasive device, the Veggie Meter, was used as a marker to evaluate consumer intake of fruits and vegetables.

3.1.2 Surveys

The survey tool was based on both a PIUKP Farmers' Market survey and a validated standard food frequency questionnaire (FFQ) called The Dietary Habits Survey from a study by Bogers et al (Am J Epi 2004).

1. The PIUKP farmers' market survey: This survey focused on assessing participants' response to the recipe sample on a 10-point Likert-scale (with 10 being "Loved

Flavor, Will Definitely Make at Home"), their likelihood of purchasing one or more of the commodities highlighted in the sampled recipe (10=most likely to purchase), and to try samples as well as take recipe cards when offered at the grocery and/or farmers market. The survey also asked the participants to report their average daily fruit and vegetable intake, in addition to their frequency of visiting a farmers' market.

2. <u>The Dietary Habits survey:</u> The Dietary Habits survey was used to assess the frequency of consumption of different groups of carotenoid-rich fruits and vegetables, that were categorized by form and type in which they were consumed.
    - The first part of the survey included questions on frequency of consumption of fruits and vegetables based on their form, i.e., *Cooked, Raw,* and *Juice.* This was followed by questions on the type of fruits and vegetables consumed and were categorized by color, i.e., *Dark Green, Light Green, Yellow/Orange, Red, Blue/Purple,* and *White*. The participants had to mark their intakes for each depending on how frequently they consumed the specific FV, with seven options ranging from *Never or Once a Month,* to *Seven Days a Week*. A standard number of servings for each category of the form and type of fruit and vegetable was provided as a reference to allow ease of reporting intakes as accurately as possible.

3.1.3 Instruments

In addition to using a combined FFQ, dietary intake of fruits and vegetables was evaluated via the Veggie Meter, measuring dermal intake of fruits and vegetables using Raman Resonance Spectroscopy (Ermakov, Sharifzadeh, Ermakova, Gellermann 2005). The Veggie Meter consists of a carotenoid scanner kit, which includes a laptop. Before the assessment can begin, the scanner is first connected to the laptop and needs to be warmed up for five minutes. Next, it is calibrated as per the instructions and the accessory tools provided in the kit. The calibration involves using a white reference followed by a dark reference, both of which then display a certain curve indicating its readiness for use.

For the carotenoid score assessment, the participants were first asked to wipe their fingertip with an alcohol swab. Next, they were asked to place their finger over a bulb-like surface in the Veggie Meter for about 20 seconds. As the light reflected on the inserted fingertip, the carotenoid levels in the skin were read on the laptop and a score was displayed on the screen anywhere from 0-1000. The score received depends on the levels of carotenoids present in skin. On average, a score of 100 corresponds to consumption of approximately one single serving of fruits and vegetables per day.

Dietary Assessment

This study focused on collection of quantitative data. Age and gender of the participants were collected as demographic information. Data from Likert-scale based questions regarding sampling impression, recipe card distribution, purchasing habits and

the average fruit and vegetable intake was included. Dietary intake was measured using i) self-reported data from the Dietary Habits Survey and ii) the scores from the dermal carotenoid scanner, which evaluates intakes of fruits and vegetables in terms of cups/day and servings/day are examined as continuous variables.

Statistical Analysis

Data was grouped using *MS Excel* and evaluated for descriptive statistics (mean and standard deviation). Next, for assessment of inferential statistics *SAS University Edition* and *SAS 9.4* were used, where correlation was evaluated using Kendall's Tau correlation coefficients. Kendall's Tau and Odds' Ratio were used as the preferred measures of association for different combinations of ordinal variables. Pearson's Correlation was performed to evaluate the relationship between self-reported intakes and dermal carotenoid scores, as both were purely continuous variables. Correlation coefficients for both Kendall's Tau (τ) and Pearson Correlation (r) range from 0-1 depending on the strength of the association between the variables (0 indicates no correlation; 0.1 indicates a weak correlation while 0.7 indicates a stronger correlation). For regression analysis, both simple and ordinal logistic regression models were run with the statistical significance set at $\alpha = 0.05$.

Questions based on the Likert-scale were evaluated as ordinal variables and were considered for measuring the correlations amongst each other as well as to predict the most significant indicator of the predictor variable. Average of the data determining the purchasing habits of consumers, their likelihood of recipe preparation and their average intake of fruits and vegetables were run as response variables against sample impression

and distribution of recipe cards which were the predictor variables. Furthermore, for analysis of fruit and vegetable intake, the dermal carotenoid score was the predictor variable and self-reported intake was the response variable. The questions for intake of carotenoid-rich fruits and vegetables were stratified in the FFQ. The total average daily intake from the FFQ was calculated by multiplying the reported intakes with the frequency of consumption. This total average daily intake was used to draw a comparison against the carotenoid scores.

For the descriptive statistics, data was presented as mean value, standard deviation and percentages. Data from frequency of intake was calculated and presented as percentages and a comparison was drawn out for total average fruit and vegetable consumption among the counties surveyed.

CHAPTER 4. RESULTS

Socio-demographic Information

A total of 300 adult participants were enrolled in the study at the farmers' markets throughout nine counties in Kentucky. The majority of the sample were women (79.4%) with a smaller percentage of men participating in the study (20.6%). The overall average age of the participants was 49.64±15.54 years, with the average female age being 49.27 years and the average age among men being 51.17 years. The number of participants varied based on county of sampling - Fayette (n=19), Hardin (n=52), Jefferson (n=42), Knox (n=22), McCracken (n=22), Montgomery (n=40), Owsley (n=37), Pike (n=37), and Trigg (n=29). The following table 4.1. provides a snapshot of the overall socio-demographic information for the respective counties surveyed (U.S. Census Bureau, 2017).

Table 4.1.1 Socio-demographic Information across the Nine Surveyed Kentucky Counties – US Census Bureau 2016

County	**Total population (July 2016)**	**Age**	**Percent with College Education**	**Median income and poverty%**	**Race and ethnicity**				
					White alone	*African American*	*Hispanic or Latino*	*Asian*	*>2 races*
Fayette	321,959	21.0% <18 yo 12.9% >65 yo	41.4%	$50661 17.9%	77.6 %	15.2%	7.2%	4.2 %	2.6 %
Hardin	108,071	24.6% <18 yo 13.7% >65 yo	23.6%	$51541 13.8%	80.5 %	12.7%	0.5%	2.3 %	3.7 %
Jefferson	771,158	22.3% <18 yo 15.7% >65 yo	31.8%	$50099 14.9%	72.3 %	22%	0.2%	2.9 %	2.4 %
Knox	31,227	23.3%<18 yo 16.9%>65 yo	10.9%	$26553 39.2%	96.8 %	1.3%	0.3%	0.3 %	1.3 %

McCracken	65,385	22.3% <18 yo, 19.4% >65 yo	22.9%	$42303 18.7%	85.3 %	11.0%	0.4%	0.9 %	2.3 %
Montgomery	27,928	23.7% <18 yo 15.7% >65 yo	16.6	$39750 17.9%	95%	2.8%	0.3%	0.4 %	1.4 %
Owsley	4,435	21.7 <18 yo 19.4% >65 yo	17.4%	$22106 45.2%	84.3 %	9.3%	5.2%	3.6 %	2.3 %
Pike	58,883	20.6% < 18yo 18.2% > 65yo	31.4%	$32816 31.4%	97.7 %	0.8%	0.1%	0.5 %	0.8 %
Trigg	14,444	21.7%<18yo 22.2%>65yo	18.0%	$45032 14.5%	90.0 %	7.0%	0.4%	0.3 %	2.2 %

Table 4.1.1 (continued)

Table 4.1.2 Demographics of the Surveyed Sample

County (n)		Average age (years)	% of male respondents	% of female respondents
Fayette (19)		47.89 ± 15.62	21.00%	79.00%
Hardin (52)		50.65 ± 16.15	19.00%	81.00%
Jefferson (42)		41.16 ± 13.24	10.00%	90.00%
Knox (22)		40.80 ± 15.54	18.00%	82.00%
McCracken (22)		47.66 ± 14.02	19.00%	81.00%
Montgomery (40)		58.16 ± 13.97	32.00%	68.00%
Owsley (37)		52.72 ± 15.60	32.00%	68.00%
Pike (37)		53.42 ± 14.50	18.00%	82.00%
Trigg (29)		21.96 ± 14.49	21.00%	79.00%
All Counties (300)	Total (males)	51.08 ± 16.91	20.60%	79.40%
	Total (females)	49.27 ± 15.19		
	Total	49.64 ± 15.55		

The Plate It Up! Kentucky Proud Farmers' Market Survey

Table 4.2.1. shows the descriptive statistics for the sampling experience of participants at the farmers' markets. Of surveyed consumers, 42.6% reported having tried a *PIUKP* recipe at least once before the scheduled sampling at their respective farmers' market. The highest rate of prior consumption was in Knox County (59.1%) and the lowest was reported in McCracken County (22.7%). Forty percent of all participants reported regularly taking recipe cards from the farmers' market and/or grocery store and 40.3% agreed that they try samples whenever provided at a farmers' market and/or a grocery store. With regards to the feedback on sample-tasting, on a Likert scale of 1-10 with 1 being "*Bad Flavor, Won't Make"* and 10 being "*Loved Flavor, Definitely Make*," the mean score for sample impression among all consumers was 8.84± 1.62, indicating a high preference of likeness. Further, on a similar scale where 1 = "*Sampling Contributes None"* and 10 = *"Sampling Contributes a Lot,"* a score of 7.94±2.26 was observed. Further, the mean score for the contribution of recipe cards to their intent to prepare the sampled recipes closely followed at 7.86±2.3 on a scale of 1-10, 1 being '*cards contributed none'* and 10 being '*cards contributed a lot'*. These results indicated that the participants found both recipe sampling and recipe cards to be important factors to aid in the preparation of respective recipes.

Table 4.2.1 Sampling experience of adults surveyed at farmers' markets across nine Kentucky counties in the summer of 2018

County (*n*)	Had you tried a PIUKP recipe at market before today? (% yes)	Do you normally try samples at the grocery or FM? (% yes)	Do you normally take recipe cards provided at the grocery or FM? (% yes)	Does sampling at the FM contribute to your plan to make the sampled recipe? 1=sampling contributes none 10= sampling contributes a lot	Do recipe cards at the FM contribute to your plan to make the recipe? 1= cards contribute none 10= cards contribute a lot	What was your impression of the PIUKP recipe sampled today? 1=poor flavor 10=loved it
Fayette (19)	26.30%	57.90%	42.12%	7.16 ± 2.01	7.58 ± 2.07	8.56 ± 1.54
Hardin (52)	46.20%	46.20%	36.54%	7.68 ± 2.36	7.58 ± 2.26	8.68 ± 1.47
Jefferson (42)	35.70%	30.95%	30.95%	7.88 ± 2.33	7.71 ± 2.42	8.73 ± 1.98
Knox (22)	59.10%	50.00%	36.36%	8.78 ± 1.72	8.87 ± 1.65	9.00 ± 1.16
McCracken (22)	22.70%	18.18%	18.18%	8.60 ± 1.97	7.62 ± 2.34	8.73 ± 1.25
Montgomery (40)	42.50%	40.00%	60.00%	8.33 ± 1.78	7.93 ± 2.30	9.39 ± 0.96
Owsley (37)	62.20%	37.84%	51.35%	8.14 ± 2.27	8.25 ± 1.88	8.78 ± 2.09
Pike (37)	35.12%	51.35%	43.24%	7.79 ± 2.33	8.11 ± 2.20	8.84 ± 1.33
Trigg (29)	44.83%	31.03%	31.03%	7.32 ± 2.93	7.21 ± 3.14	8.56 ± 2.23
All Counties (300)	42.60%	40.33%	40.00%	7.94 ± 2.26	7.86 ± 2.30	8.84 ± 1.62

Further analysis was performed to study the correlation and regression between the variables. Kendall's Tau correlation (τ) analysis, as displayed in table 4.2.2, revealed a positive relationship between consumers' impression of the sample and their intent to purchase the produce the very same day ($\tau = 0.36$, $p<0.0001$). Moreover, consumers' sample impression showed a positive but weak association with their intent to purchase the produce in the future ($\tau = 0.43$, $p<0.0001$). Sampling impression and consumers' intent to prepare said recipes also shared a strong positive association ($\tau = 0.51$, $p<0.0001$). However, a relatively weaker, yet positive, correlation was found between consumers' habit of taking recipe cards and their intent to prepare the recipe(s) ($\tau = 0.35$, $p<0.0001$).

Table 4.2.2 Kendall's Tau Correlation Coefficients (□) for the Associations Between the Various Predictor and Response Variables

Variables	Kendall's Tau (τ)
Sample impression and same-day purchase	0.36 p<0.0001
Sample impression and future purchase	0.43 p<0.0001
Sample impression and recipe preparation	0.51 p<0.0001
Recipe cards and recipe preparation	0.35 p<0.0001

As a result of positive correlations, the regression analyses developed significant models for the respective predictor variables. Table 4.2.3 shows the simple linear regression (SLR) models that predicted the consumers' intent of purchasing produce on account of sample-tasting. The first model, studying the effect of sample impression on

same-day purchase reached significance, i.e., it successfully predicted consumers' purchasing habits with respect to same-day purchase ($F(1,293) = 50.01$, $p<0.0001$). The model explained 14.58% of variance in the intent of same-day produce purchases, which was measured by sample impression ($\beta = 0.59$, $t = 7.07$, $p<0.0001$). Therefore, for every increase in sample rating by 1 point, intent to purchase produce on the same day increased by 0.59 times.

Likewise, the table also includes the SLR model between sample impression and intent of consumers to purchase produce in the future as a result of tasting the sample. The regression model shows significance indicating the successful prediction of consumers' purchasing habits of produce in the future on account of sample-tasting ($F(1,295) = 88.77$; $p<0.0001$). The model explained 23.13% of variance in the intent of future produce purchase by consumers, measured by the impression of sample ($\beta = 0.52$, $t = 9.42$, $p<0.0001$). This means that, for every increase in sample rating by 1, the likelihood of consumers to purchase said produce in the future increased by 0.52 times. Moreover, sample impression was also seen as a significant predictor of consumers' intent for recipe preparation ($F(1,294) = 184.37$, $p<0.0001$). The model predicted 38.54% of the variance in the intent of recipe preparation that was measured by consumers' impression of the sample ($\beta = 0.86$, $t = 13.58$, $p<0.0001$), which translates to that with every increase in sample rating by 1 point, the likelihood of consumers to prepare the sampled recipe increased by 0.86 times.

Table 4.2.3 Simple Linear Regression Models for Consumers' Purchasing Habits and Intent of Recipe Preparation as a result of Sample-tasting

S. No.	Variables	F-value	R-Square (% variability)	Parameter Estimate (β)	t-statistic	Figures
1.	Sample impression and same-day purchase	50.01 p<0.0001	14.58% p<0.0001	0.59	7.07 p<0.0001	4-1
2.	Sample impression and future purchase	88.77 p<0.0001	23.13% p<0.0001	0.52	9.42 p<0.0001	4-2
3.	Sample impression and recipe preparation	184.37 p<0.0001	38.54% p<0.0001	0.87	13.58 p<0.0001	4-3

Figure 4-1 Simple Linear Regression model for sample impression (*SI*) and same-day purchase (*Today*)

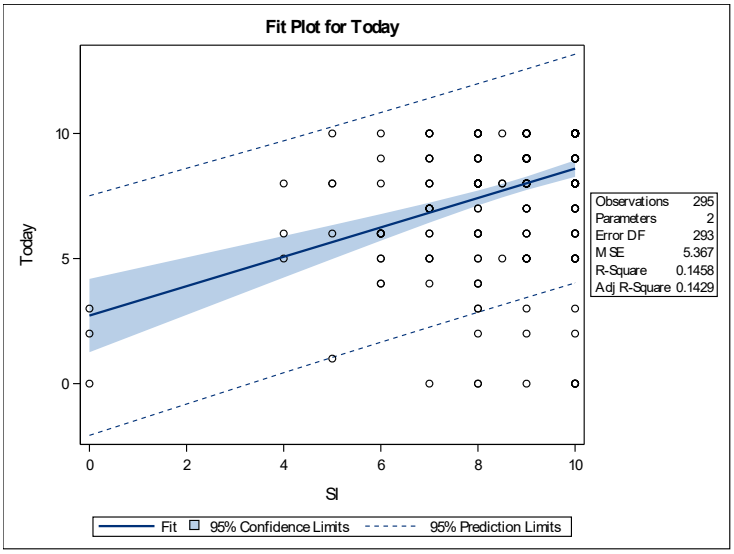


Figure 4-2 Simple Linear Regression model for sample impression (*SI*) and future purchase (*Later*)

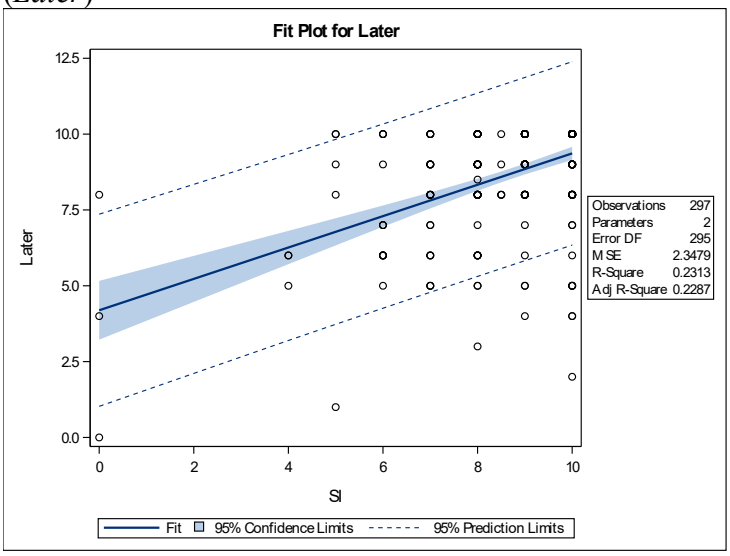
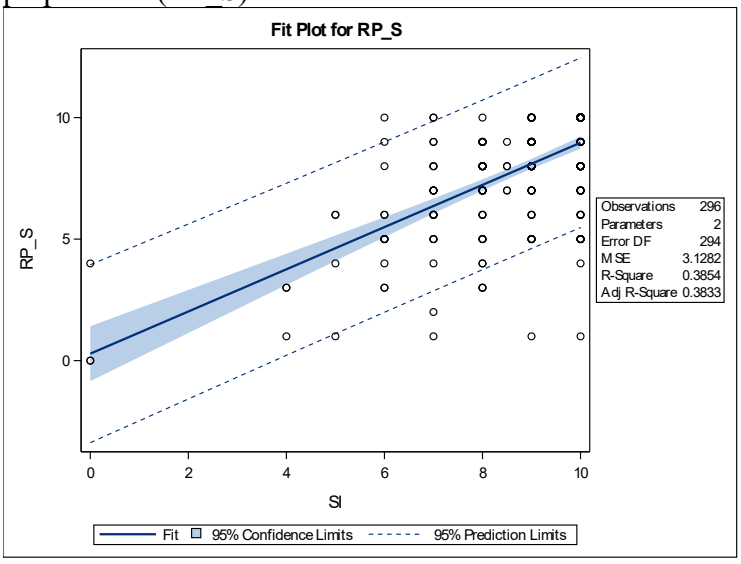


Figure 4-3 Simple Linear Regression model for sample impression (*SI*) and intent of recipe preparation (*RP_S*)



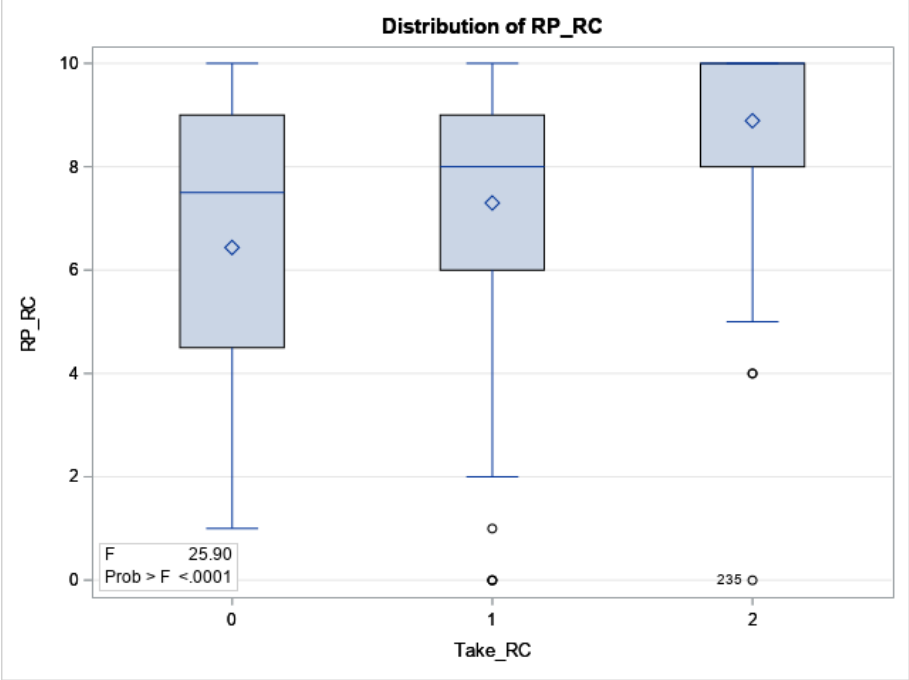
As shown in table 4.2.4, one-way analysis of variance (ANOVA) test demonstrates the effect of obtaining recipe cards on consumers' likelihood of preparing said recipes revealed significant results. The overall F test ($F = 25.90$, $p<0.0001$) for the model accounts for a significant portion of variability in the likelihood of recipe preparation. Figure 4-4 shows the boxplot from the one-way ANOVA test. The ascending upward bump in the

boxplot across different levels of taking recipe cards (*0 – not usually, 1 – sometimes, 2 – frequently)* indicates that the data is negatively skewed. This suggests that with the increase in frequency of obtaining recipe cards, there was a significant increase in the consumers' intention to prepare respective recipes.

Table 4.2.4 One-way ANOVA test for the effect of procurement of recipe cards on intent of recipe preparation

S. No.	Variables	F-value	Mean for Intent of Recipe Preparation	Figure
1.	Procurement of recipe cards	25.90 p<0.0001	7.85	4-4

Figure 4-4 Box Plot of Intent of Recipe Preparation (*RP_RC*) based on the frequency of procuring recipe cards (*Take_RC*)



An ordinal logistic regression model was run to assess whether the frequency of procurement of recipe cards and trying samples when provided were a significant predictor of the consumers' past average fruit and vegetable intake. The results, as shown in table 4.2.5, showed that the regression coefficients for the average fruit and vegetable intake (β1

=0.0655 p=0.4543; β2 = 0.08 p=0.3603) were not found to be statistically different from zero in estimating the frequency of consumers trying samples and procuring recipe cards respectively.

Furthermore, table 4.2.6 shows the odds ratios for the effect of average fruit and vegetable intake of consumers. The results suggest that with a unit increase in the average fruit and vegetable intake, the odds for taking recipe cards (OR = 1.068, 95% CI 0.899-1.267) and trying samples when provided (OR = 1.083, 95% CI 0.913-1.286) increased by 1.068 and 1.083 times respectively.

Table 4.2.5 Ordinal Logistic Regression Results

S. No.	Variables	Parameter (β)	Estimate	Pr > ChiSq
1.	Avg_FV and Trying Samples	β_1	0.0655	0.4543
2.	Avg_FV and Taking Recipe Cards	β_2	0.08	0.3603

Table 4.2.6 Odds Ratio Estimates for Average Fruit And Vegetable (FV) Intakes

S. No.	Effect of average FV intake on:	Point Estimate	95% Wald Confidence Limits	
1.	Frequency of taking recipe cards	1.068	0.899	1.267
2.	Frequency of trying Samples	1.083	0.913	1.286

The Dietary Habits Survey

The *Dietary Habits Survey*, which focused on the participants' intakes of different categories of fruits and vegetables and included their dermal carotenoid scores, was analyzed using multiple linear regression and Pearson's correlation coefficient.

As shown in table 4.3.1, none of the nine variables indicating self-reported fruits and vegetable intake (ranging from cooked, raw, juiced forms to dark green, light green, yellow/orange, red, blue/purple or white colored fruits and vegetables) were found to be a significant predictor of the dermal carotenoid scores.

Table 4.3.1 Multiple Linear Regression Model of the Dermal Carotenoid Scores And The Self-Reported Intakes Of Different Forms And Types Of Fruits And Vegetables

Variable	p-value
Dermal Carotenoid Scores (Intercept)	<.0001
Cooked	0.4642
Raw	0.1772
Juice	0.7720
Dark green	0.4611
Light green	0.1032
Yellow/Orange	0.7862
Red	0.1387
Blue/Purple	0.2834
White	0.2106

Similarly, the Pearson's correlation analysis revealed that the dermal carotenoid scores failed to significantly correlate with the self-reported intakes, as evident by table 4.3.2.

Table 4.3.2 Pearson Correlation Coefficients (R) for the Associations between Dermal Carotenoid Scores and Self-Reported Intakes of Different Forms and Types of Fruits and Vegetables

Dermal carotenoid score and:	Pearson's correlation coefficient (r)	p-value
Cooked FV	0.12097	p=0.0392
Raw FV	0.099	p=0.0912
Juiced FV	-0.03	p=0.615
Dark green FV	0.07384	p=0.2148
Light green FV	0.00378	p=0.9497
Yellow/Orange FV	0.0074	p=0.9
Red FV	0.08385	p=0.1595
Blue/Purple FV	0.056	p=0.352
White FV	-0.01	p=0.8645

Further analysis of intakes, as displayed in table 4.3.3, shows the descriptive statistics for the mean self-reported consumption (MSRC) of fruits and vegetables and the mean dermal carotenoid score (MDCS) for each county. Jefferson county consumers had a relatively lower MDCS at 173.2±79.03, which indicates intake of approximately one and three-quarters servings of colorful fruits and vegetables on a daily average, with three-quarters of a serving as a variability. The highest MDCS was produced among participants from Hardin county at 222.02±88.91, suggesting that the people overall consumed a daily

average of two and one-quarter of servings, with a variability of almost an entire serving. However, the self-reported average intake of carotenoid-rich produce was the lowest in Fayette county at 0.95±1.12 servings, indicating that people reported consuming a little less than a single serving of fruits and vegetables on a daily average. On the other hand, the highest self-reported consumption was among the Knox county consumers who reported eating 1.43±1.57 servings on a daily average. Given by the results of MSRC and MDCS, all the counties reportedly underestimated their daily intakes.

Table 4.3.3 County-Level Comparison of Mean Self-Reported Intake of Carotenoid-Rich Fruits and Vegetables and Dermal Carotenoid Scores

S. No.	Counties (n)	Mean Self-Reported Consumption (MSRC)	Mean Dermal Carotenoid Score (MDCS)	Level of consumers' estimation based on the county's average
1.	Fayette (19)	1.2 ± 1.36	197.85 ± 105.37	Underestimation
2.	Hardin (52)	1.08 ± 1.17	222.02 ± 88.91	Underestimation
3.	Jefferson (42)	0.95 ± 1.12	173.2 ± 79.03	Underestimation
4.	Knox (22)	1.43 ± 1.57	196.4 ± 70.4	Underestimation
5.	McCracken (22)	1.2 ± 1.21	189.86 ± 113.01	Underestimation
6.	Montgomery (40)	1.17 ± 1.27	180.33 ± 135.27	Underestimation
7.	Owsley (37)	1.13 ± 1.32	179.1 ± 74.65	Underestimation
8.	Pike (37)	1.06 ± 1.14	187.3 ± 96.33	Underestimation

9.	Trigg (29)	1.26 ± 1.4	218.6 ± 114.4	Underestimation

CHAPTER 5. DISCUSSION

The purpose of this study was to assess the effects of sampling *PIUKP* recipes and distribution of *PlUKP* recipe cards on the likelihood of influencing purchasing habits as well as intent of recipe preparation among consumers at farmers' markets across nine Kentucky counties during the three peak farmers' market months of June, July and August. An additional component of the study was to determine the correlation between consumers' dermal carotenoid scores and their self-reported intakes of fruits and vegetables.

Use of Promotional Strategies

The results of this study indicated that both sampling of recipes and distribution of recipe cards increased the likelihood of consumers to purchase fruits and vegetables, and also influenced their intention to make respective recipes. These results correspond with the study's primary hypotheses and are well-supported by the findings of Chen et al (2016) who determined that food sampling is a significant promotional tool. Moreover, as Jilcott et al (2014) found that the higher the use of farmers' markets, the higher are the chances for consumers to shop for fresh produce. This stands true especially among married female consumers with agricultural interests (Gumirakazi et al 2014) who reported visiting the farmers' markets frequently to purchase fresh produce. It can be therefore hoped that sampling of healthy fruit and vegetable recipes holds the potential to positively influence the produce intake among locals.

The study also aimed at exploring whether the intake of fruits and vegetables among consumers was a reliable predictor of their likelihood and interest in trying the given samples and/or obtaining recipe cards. The results however failed to meet the hypothesis.

On a positive note, it was found that the participants in this study were willing to try the samples and take recipe cards despite their past levels of fruit and vegetable intake.

Study Site and Target Sample

As farmers' markets were the primary setting for this study, it could be interpreted that the target sample (i.e., consumers at the farmers' markets) is predisposed and inclined toward consuming more fresh produce, and hence the effect of sampling and recipe card distribution were significant on influencing their purchasing habits. However, the average intake of participants throughout the nine counties revolved around a single serving on a daily average. In fact, the carotenoid scores depicted an average score of 222.02±88.91, which translates to consumption of approximately two and one quarter servings of fruits and vegetables. Therefore, it can be concluded that the intakes of farmers' market consumers reflect the intakes of a typical local Kentuckian who consumes anywhere from one-half to two servings of fruits and vegetables in a day (CDC 2017).

Produce Consumption

An unanticipated result that was observed, with respect to produce consumption, was that the participants' self-reported intakes of fruits and vegetables, on an average, were found to be lower than their respective dermal carotenoid score. This disagrees with several studies (Moghames et al 2010) (Institute of Medicine US 2002) that have shown that people tend to overestimate their dietary intakes, especially when reporting in a food frequency questionnaire. Inaccurate reporting of frequency of consumption and/or the amount of consumed and/or/due to inability of following the survey instructions could be an additional source for this misestimation.

Strengths of the Study

The study accentuates the value of the PIUKP recipes, which are healthier versions of traditional recipes. These recipes have been developed through a rigorous testing procedure as part of the undergraduate course at UK DHN i.e. DHN – 304 Experimental Foods and been further approved to be included as a PIUKP recipe by undergoing a taste-testing evaluation. The study thereby highlights the importance of PIUKP recipes, and the spectacular way they were received by the target audience, with a mean sample impression of 8.84±1.62 on a scale of 1 to 10 (1 = '*poor flavor, won't make'* and 10 = '*loved flavor, will definitely make*')

Apart from these, this study is unique in applying the tool of food sampling at and by using farmers' markets as the main consumer contact point, particularly with the goal of influencing consumers' fruit and vegetable purchasing habits. Moreover, it contributes to the literature by reiterating the value of providing samples at consumers' points of contact by a twofold reason – i) the sampling of recipes helped increase people's exposure to a variety of produce and ii) sampling increased their likelihood of produce purchase and positively, albeit indirectly, influenced their dietary intakes. In addition, perhaps the large number of people that kept gathering to taste a sample acted as an indirect way of encouragement to other consumers at the market to try the samples.

This is also the first research of its kind to use a dermal carotenoid scanner for assessing produce intake in a community setting in the state of Kentucky. The aim of exploring the association between the skin carotenoid concentrations and the intakes that the participants reported in the surveys adds to the distinctiveness of the study. This approach can be further used to guide researchers in a similar design of study.

Limitations

This study had a few limitations. Firstly, it was a cross-sectional study and did not aim at observing the pronounced (or lack of) effects of the promotional strategies, which could have otherwise been used as proven methods to improve produce intake among consumers.

Secondly, the study was performed over a short period of three months, which although peak, is half the duration of the entire farmers' market season. This was due to reaching the maximum limit of study participants (n=300) that could be supported by the research funds. Moreover, it accounts for data from only a single farmers' market from each of the nine surveyed counties which was collected at only one point of time. Statistically speaking, out of a total of 120 counties in Kentucky, this study represents only 7.5% of the state.

Third, with regards to the correlation between the dermal carotenoid scores and the self-reported intakes, there was lack of significant association between the two. This could be because the *Dietary Habits Survey* spanned an intake period of the past one month whereas the carotenoid scanner measures intakes for the past two months. Other like misestimation and/or misreporting of actual dietary intakes could also be contributing factors for the lack of relationship between the two assessment methods. The principal investigator observed that few participants found the *Dietary Habits Survey* difficult to understand at first, while few others caught on after answering the first couple questions. Therefore, a user-friendly and better validated survey tool could be used to discourage misreporting of data. For example, other self-reported dietary assessment tools like a similar FFQ spanning intakes for the same time period as the biomarker may be used to

increase accuracy of the relationship. Additionally, other tools like food logs, standardized 24-hour Dietary Recall for the same duration of time can be recorded and used for analysis against the biomarker.

Lastly, the data evaluated for comparison of *MSRC* and *MDCS* used the entire county's average which gave a picture of the level of intake and the average carotenoid score for the respective county. No analysis was conducted for an individual's self-reported intake and carotenoid score.

Implications

The *2015-2020 American Dietary Guidelines* recommend a daily intake of at least 5 servings of fruits and vegetables combined. According to both the CDC (2017) and the results obtained after this research, many adults in the US fail to reach the minimum level of five daily servings. As several studies have reported a positive association between use of farmers' markets and produce intake among consumers (McCormack, Laska, Larson and Story 2010) (Pitts, Gustafson, Qu, Mayo, Ward, McGuirt and Ammerman 2014) it is critical to bridge the gap between the two.

This study offers two effective promotional strategies of recipe sampling and recipe card distribution which can be successfully used to promote fruit and vegetable intake, which is a much-needed intervention, especially during this time of an obesity epidemic.

Future studies can also closely look into using the dermal carotenoid scanner for encouraging people to consume more fruits and vegetables and analyze the approximate level of intake in the area.

APPENDICES

APPENDIX 1. IRB Approval Letter

University of Kentucky | Office of Research Integrity
IRB, RDRC

Initial Review

Approval Ends:	IRB Number:
5/28/2019	44639

TO: Umaima Sidra Afsheen Syeda,
Dietetics and Human Nutrition
PI phone #: 502-415-2735

PI email: umaima.syeda@uky.edu

FROM: Chairperson/Vice Chairperson
Non Medical Institutional Review Board (IRB)

SUBJECT: Approval of Protocol

DATE: 5/30/2018

On 5/29/2018, the Non Medical Institutional Review Board approved your protocol entitled:

Promotion of fruit and vegetable intake through recipe card distribution and sampling at farmers' markets throughout Kentucky.

Approval is effective from 5/29/2018 until 5/28/2019 and extends to any consent/assent form, cover letter, and/or phone script. If applicable, the IRB approved consent/assent document(s) to be used when enrolling subjects can be found in the "All Attachments" menu item of your E-IRB application. [Note, subjects can only be enrolled using consent/assent forms which have a valid "IRB Approval" stamp unless special waiver has been obtained from the IRB.] Prior to the end of this period, you will be sent a Continuation Review Report Form which must be completed and submitted to the Office of Research Integrity so that the protocol can be reviewed and approved for the next period.

In implementing the research activities, you are responsible for complying with IRB decisions, conditions and requirements. The research procedures should be implemented as approved in the IRB protocol. It is the principal investigator's responsibility to ensure any changes planned for the research are submitted for review and approval by the IRB prior to implementation. Protocol changes made without prior IRB approval to eliminate apparent hazards to the subject(s) should be reported in writing immediately to the IRB. Furthermore, discontinuing a study or completion of a study is considered a change in the protocol's status and therefore the IRB should be promptly notified in writing.

For information describing investigator responsibilities after obtaining IRB approval, download and read the document "PI Guidance to Responsibilities, Qualifications, Records and Documentation of Human Subjects Research" available in the online Office of Research Integrity's IRB Survival Handbook. Additional information regarding IRB review, federal regulations, and institutional policies may be found through ORI's web site. If you have questions, need additional information, or would like a paper copy of the above mentioned document, contact the Office of Research Integrity at 859-257-9428.

APPENDIX 2. IRB Stamped Consent Form

IRB Approval
5/29/2018
IRB # 44639
ID # 32966

Dear research study participant,

Researchers at the University of Kentucky are inviting you to take part in a survey about the impact of having recipe samples and recipe cards at farmers' markets on consumer purchase and consumption of locally grown fruits and vegetables. You are being invited to take part in this research study because you are an adult consumer at the farmers' market and are 18 years of age or older. This study is being conducted as part of the Plate It Up! Kentucky Proud (PIUKP) project. This project includes the development of healthy recipes using locally grown fruits and produce. You should not take part in this study if you are younger than 18 years and/or if you have any significant food allergies and/or dietary restrictions.

As part of this study, you will be asked to taste a PIUKP sample, receive a PIUKP recipe card, take a short survey, and have your skin carotenoid levels measured at the farmers' market. Carotenoids are compounds found in fruits and vegetables, such as beta carotene in carrots.

First, you will be provided with a PIUKP sample prepared by the FCS Extension Agent and recipe card to accompany that recipe. Following tasting, you will be given a survey to take regarding the sample you tasted, the recipe card, how frequently you visit the farmers' market, and your fruit and vegetable consumption. Once the survey is completed, your skin carotenoid levels will be measured using a device called the Veggie Meter. You'll be asked to place your finger in the device for 20 seconds. The light shines on the inserted finger, reads the carotenoid levels in skin and displays the score on the screen. The principal investigator (PI), Ms. Syeda will answer any questions you may have.

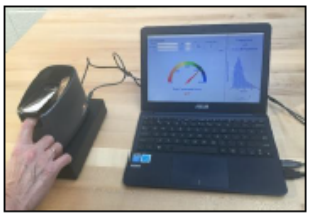


Fig. 1. Measuring skin carotenoid score using a Veggie Meter.

Although you may not get personal benefit from taking part in this research study, your responses may help us understand more about the potential effects of recipe sampling and recipe card distribution at farmers' markets on purchase and consumption of locally grown fruits and vegetables. Some volunteers experience satisfaction from knowing they have contributed to research that may possibly benefit others in the future. As well, you may find it interesting to know your skin carotenoid levels, which can be an indication of your recent beta-carotene rich fruit and vegetable consumption.

You will receive a $10 gift card for taking part in this study.

The survey/questionnaire will take about 5 minutes to complete.
There are no known risks to participating in this study. Your response to the survey is confidential which means no names will appear or be used on research documents or be used in presentations or publications.

We hope to receive completed questionnaires from about 300 people, so your answers are important to us. Of course, you have a choice about whether or not to complete the survey/questionnaire, but if you do participate, you are free to skip any questions or discontinue at any time.

If you have questions about the study, please feel free to ask; my contact information is given below. If you have complaints, suggestions, or questions about your rights as a research volunteer, contact the staff in the University of Kentucky Office of Research Integrity at 859-257-9428 or toll-free at 1-866-400-9428.

Thank you in advance for your assistance with this important project.

University of Kentucky Survey/Questionnaire Cover Letter Template [F1.0355]

44639
ID # 32966

Sincerely,

Umaima Syeda. MS candidate
Dietetics and Human Nutrition, University of Kentucky
PHONE: 502-415-2735
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Tammy J. Stephenson, PhD
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APPENDIX 3. The *Plate It Up! Kentucky Proud* Farmers' Market Survey

University of Kentucky
College of Agriculture, Food and Environment

Plate It Up! Kentucky Proud

Farmers' Market Survey

_____ *County Farmers' Market –*

Name: _____

Gender: _____; Age: _____

Your input will help in the development of recipes using locally grown produce and design of future market sampling activities. For your information, in case you may have food allergies, the recipe you are testing contains _____.

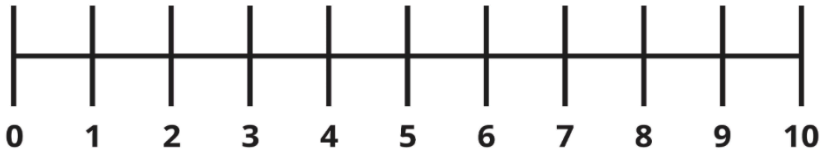
In order to follow up about your experience today, you will receive an email from UK in a few weeks. This follow-up is a very important part of our project. Your contact details will not be included in the data provided to researchers; it will only be used for the purpose of sending you a link to the very important follow-up survey. Please comment honestly. Your response is completely confidential and will be grouped with other participants throughout Kentucky.

Had you tasted a *Plate It Up! Kentucky Proud* recipe before today?

_____ Yes _____ No _____ Not Sure

What was your impression of the "_____" sample you tasted today?

Bad Flavor, Wouldn't Make *Loved Flavor, Definitely Make*

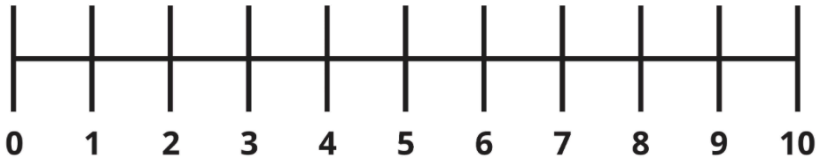


Before arriving at the farmers' market today, did you plan to buy _____?

_____ Yes _____ No

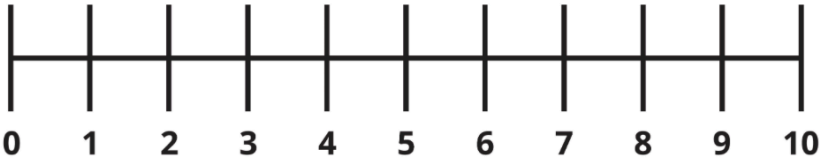
As a result of tasting the sample, how likely are you to buy _____today?

Less likely to Buy *More likely to Buy*



As a result of tasting the sample, how likely are you to buy _____at a later date (either at grocery or farmers market)?

Less likely to Buy *More likely to Buy*



Do you normally try samples of recipes at the grocery or farmers market?

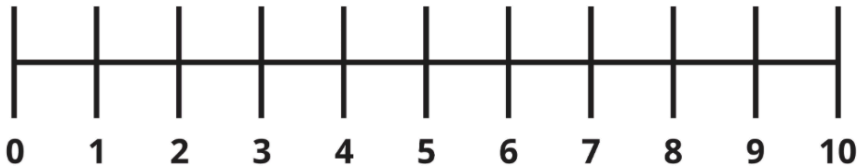
_____ Not Usually _____ Sometimes _____ Frequently

Do you normally take recipe cards, if provided, from the grocery or farmers market?

_____ Not Usually _____ Sometimes _____ Frequently

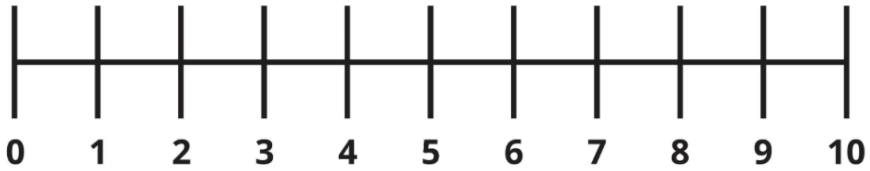
Does the **sample** of _____contribute to your plan to **make the recipe at home?**

Sampling contributed none *Sampling contributed a lot*



Do the _____ **recipe cards** contribute to your plan to **prepare ANY item using** _____ at home?

Recipe card contributed none *Recipe card contributed a lot*



How many servings of fruits and vegetables do you consume PER DAY?

Fruits: _____ servings per day Vegetables: _____ servings per day

How often do you visit the following during the Kentucky main growing season?

_____ Ct

Farmers' Market: _____ Weekly _____ Bi-weekly _____ Monthly _____ Less than once a month

ANY farmers market: ____ Weekly _____ Bi-weekly _____ Monthly _____ Less than once a month

---

THANK YOU for your time and participation

APPENDIX 4. The Dietary Habits Survey

I. Dietary Habits Survey: The questions in this questionnaire refer to the **past month**. Please could you mark:

- **how often** you ate each product on average during the past month.
- **how much** of a product you took on average on a day when you ate or drank it.

Example:

Given that you ate bananas on two days a week during the past month , and you took one banana on such a day, you fill in:

										On a day when you ate or drank this, how much did you take?					
How often did you eat on average during the past month?	Never or less than 1 a month	1-3 days a month	1 day a week	2 days a week	3 days a week	4 days a week	5 days a week	6 days a week	7 days a week	1	2	3	4	5 or more	
Bananas	☐	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☐	☐	☐	pieces

- If you did not take a product during the past month, please do not forget to mark the category "never or less than 1 a day a month". In that case, it is not necessary to report a portion size.

  In all other cases, please also mark the amount you eat or drink. Report the amount you **yourself** eat or drink, and not the amount for the whole family.

  Please read carefully every question and choose the answer that suits you best.

Now the questionnaire begins:

How often did you eat on average during the past month?	Never or less than 1 a month	1-3 days a month	1 day a week	2 days a week	3 days a week	4 days a week	5 days a week	6 days a week	7 days a week	On a day when you ate or drank this, how much did you take? 1	2	3	4	5 or more serving spoons/ glasses	Std. serving size*
Form consumed:															
Vegetables, cooked. *(Boiled, fried, steamed, cooked otherwise)*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	*1/2 cup*
Raw fruits; Raw vegetables and salad *(Banana, apple, grapes; lettuce, cucumber, tomato, etc.)*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	*1/2 cup; 1 cup*
Fruit and vegetable juice *(e.g., orange juice, fresh or from a carton, tomato)*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	*1/2 cup*
Type consumed:															
Dark green FV: ***(Broccoli, spinach, greens, zucchini, lettuce, kiwi, artichokes, green peppers and beans, etc.)***	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	*1/2 cup or 1 whole fruit/ vegetable*
Light green FV: ***(Green apples, honeydew melon, cabbage, Brussels sprouts, spring onions, soybeans, turnips, etc.)***	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	*1/2 cup or 1 whole fruit/ vegetable*
Yellow/Orange FV: *(Oranges, peaches, corn, cantaloupe, orange peppers, sweet/red potatoes, squash, pumpkins, carrots, etc.)*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	*1/2 cup or 1 whole fruit/ vegetable*
Red FV: *(Raspberries, cranberries,cherries, strawberries, red apples, watermelon, pomegranate, pink grapefruit, tomatoes, red potatoes, red cabbage, beets, etc.)*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	*1/2 cup or 1 whole fruit/ vegetable*

Blue/Purple FV: *(Blueberries, blackberries, black raspberries, eggplant, purple cabbage, etc.)*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	*1/2 cup or 1 whole fruit/ vegetable*
White FV: *(Bananas, onions, cauliflower, cabbage, white potatoes, mushrooms etc.)*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	*1/2 cup or 1 whole fruit/ vegetable*

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VITA

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- Student Committee Chair, Indians in Nutrition and Dietetics – Member Interest Group, Academy of Nutrition and Dietetic, July 2018 - present
- Lecturer, Dept. of Food and Nutrition, Osmania University College for Women, Hyderabad, January 2016 – November 2016

Scholastic and Professional Honors:

- Community Service Award 2019, Bluegrass Academy of Nutrition and Dietetics
- Human and Environmental Sciences' Research Activity Award, School of Human and Environmental Sciences, University of Kentucky, 2017

Publications:

- Syeda, U. S. A., Stephenson, T., Cupp, M., Houlihan, J., Galaniha, T. 2018. Recipe Sampling and Recipe Card Distribution at Farmers' Markets Positively Correlated With Intent to Prepare Recipes Using Locally Grown Fruits and Vegetables. *Journal of Nutrition Education and Behavior*, *50(7)*, S164 - S165