



Herbs and spices increase liking and preference for vegetables among rural high school students



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ABSTRACT

Purpose: Vegetable consumption in youth is below recommendations and strategies to increase intake at school are needed. We investigated barriers to vegetable intake at a rural public high school and evaluated whether new vegetable recipes using herbs and spices would increase liking and preference for vegetables served to adolescents at this school.

Methods: Before recipe development, herb and spice familiarity and barriers to vegetable intake were assessed through surveys with a sample of students, parents, and cafeteria staff at the high school. Recipes for vegetables were then developed using spice blends (including dill, coriander, cumin, etc.) uniquely formulated for each vegetable. To evaluate recipe acceptance, we assessed liking (100 mm visual analog scales) and preference (forced choice) among students (N 's = 96–110; aged 14–18 years) for 8 plain (oil and salt) and 8 seasoned vegetables. Liking ratings between plain and seasoned vegetables were compared with paired T -tests. Preferences were compared by chi-square tests.

Results: Students reported higher liking for several seasoned recipes compared to plain: broccoli ($P = 0.02$), vegetable dip ($P < 0.0001$), black beans and corn ($P < 0.001$), and cauliflower ($P = 0.01$). Students preferred the seasoned recipe to the plain for corn and peas ($P = 0.002$), broccoli ($P = 0.02$), dip ($P < 0.0001$), black beans and corn ($P < 0.001$), cauliflower ($P < 0.0001$), and green beans ($P = 0.02$).

Conclusions: Common herbs and spices improved liking and preference for several school lunch vegetables compared to plain varieties among rural high school students. Future research will test the impact of offering these vegetables in the school lunch program on student vegetable intake.

1. Introduction

Vegetables are important to dietary health because they are high in fiber, vitamins, and minerals, and most are low in energy (Liu, 2013). Increased vegetable intake is associated with reduced risk for chronic diseases such as cardiovascular disease and some cancers (Boeing et al., 2012; Bradbury, Appleby, & Key, 2014). Consequently, the 2015–2020 Dietary Guidelines for Americans recommends adolescents aged 14–18 years old consume 2.5–4 cup-equivalents of vegetables daily (2015–2020 Dietary Guidelines for Americans). Analysis of current consumption patterns, however, suggests that only ~2.1% of American adolescents meet these recommendations (Moore, Thompson, & Demissie, 2017). One reason for low vegetable consumption among youth is the taste. Vegetables can impart undesirable

flavors that can lead to aversion (Dinehart, Hayes, Bartoshuk, Lanier, & Duffy, 2006; Sharafi, Hayes, & Duffy, 2013). Many vegetables contain bitter or sour qualities, and also lack sweetness which is a key factor for acceptance among children (Mennella & Bobowski, 2015). In addition, genetic differences in the ability to taste bitter thiourea compounds have also been linked to decreased intake and acceptance of some bitter vegetables (Dinehart et al., 2006; Duffy et al., 2010). Poor appearance and texture, both of which can be influenced by cooking method, are also known barriers for vegetable acceptance (Zeinstra, Koelen, Kok, & de Graaf, 2007). Given these challenges, novel and effective strategies are needed to improve vegetable consumption in adolescents. In the current study, we test the effectiveness of using herbs and spices to increase liking and preference for vegetables among rural high school students.

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Multiple strategies have been successful at increasing vegetable intake in younger children. These include hiding puréed vegetables within entrees (Spill, Birch, Roe, & Rolls, 2011), or serving raw vegetables with seasoned dips (Fisher et al., 2012; Savage, Peterson, Marini, Bordi, & Birch, 2013), increasing vegetable portion size (Miller et al., 2015; Spill, Birch, Roe, & Rolls, 2010) or serving vegetables as a first course (Elsbernd et al., 2016). Additionally, efforts to improve vegetable intake in schools include “chefs in schools” interventions (Cohen et al., 2015) and the addition of salad bars to school lunch programs (Adams, Bruening, Ohri-Vachaspati, & Hurley, 2016). These efforts are promising, but additional work is still needed to provide sustainable and effective strategies for adolescents. Previous work suggests vegetable intake often decreases from childhood to adolescence (Lytle, Seifert, Greenstein, & McGovern, 2000) and that dietary habits in adolescence may carry into adulthood (Lien, Lytle, & Klepp, 2001). Rural youth also have a higher chance of having obesity than urban youth (Johnson & Johnson, 2015). Focused interventions on this population are crucial for implementing lifelong dietary habits.

In the United States, the National School Lunch Program serves more than 30 million children annually and provides 33% of a child’s daily energy needs (Cullen & Chen, 2017). Consequently, lunch programs in high schools are critically important settings for improving the dietary quality of American youth. In this setting, one potential strategy for improving vegetable acceptance and consumption is the use of herbs and spices to improve palatability. Herbs and spices provide flavor without adding significant energy, sugar, saturated fat, or sodium. Herbs and spices have been used globally for centuries to add flavor to cuisine or for the treatment of disease prior to modern medicine (Tapsell et al., 2006). Many herbs and spices contain antioxidant polyphenols, which may be beneficial to health (Tapsell et al., 2006; Vallverdu-Queralt et al., 2014). For example, capsaicin, the spicy compound in chili peppers, and garlic have both been shown to reduce blood pressure (Sun, Xiong, & Zhu, 2016; Varshney & Budoff, 2016). Recent work has also shown that perceived heat from chili peppers may correlate with increased post-meal satiety (Andersen, Byrne, Bredie, & Moller, 2017). Furthermore, dried herbs and spices are shelf-stable due to their low water activity, making them feasible for use in institutional feeding settings such as school cafeterias. Prior work has shown that herbs and spices can be used to improve acceptability of reduced-fat (Peters, Polsky, Stark, Zhaoxing, & Hill, 2014) and low-sodium (Ghawi, Rowland, & Methven, 2014) foods. Whether they can be used to improve liking of foods with lower palatability such as vegetables is unclear.

Only two studies to date have directly evaluated the influence of herbs and spices on vegetable consumption in children and adolescents. D’Adamo and colleagues reported that a school-based spice education program can improve high school students’ attitudes toward vegetables (D’Adamo et al., 2016), while Zellner and colleagues reported that chef-prepared meals (using herbs and spices combined with improved preparation methods) increased consumption of sweet potatoes and cauliflower in elementary school children (Zellner & Cobuzzi, 2017). Collectively, these limited data suggest herbs and spices may be effective at increasing vegetable acceptance and intake in a school setting.

This paper describes the first two phases of an intervention to test the effect of using herbs and spices to increase vegetable intake in rural middle and high school students. In the first phase of the study, we developed surveys for parents, students, and cafeteria food service staff, to evaluate herb and spice familiarity and to define barriers for vegetable consumption in the schools. In the second phase, we tested students’ liking and preference for vegetables prepared with herbs and spices for the school lunch program. In this phase, we hypothesized that “seasoned” vegetables prepared with herbs and spices (along with minimal oil and salt) would be liked and preferred more than “plain” vegetables (also prepared with the same minimal amount of oil and salt).

2. Methods

2.1. Study design

This is a cross-sectional study assessing liking and preference for plain and seasoned vegetables in a population of middle/high school students (aged 14–18 years) attending a rural Pennsylvania public school. Liking and preference for seasoned and plain (prepared with minimal salt and oil) vegetables were evaluated via taste tests performed in the lunch room during the students’ lunch time (10:30 am–12:00 pm). These were repeated on separate days for each vegetable recipe, for a total of nine visits (Sept–Dec 2016), one for each vegetable recipe, plus an additional visit to retest one of the vegetables (carrots) to clarify initial results.

2.2. Participants

School food service staff, students, and parents at a rural high school participated in the project. The participating school was composed of ~950 students (grades 6–12), who were predominantly white (96.3%) with ~39% of students receiving free or reduced lunch (Student Poverty Concentration-2014, 2014). The survey phase was conducted during Spring 2015. A research assistant attended home economics classes at the school to discuss the project and elicit interest from student volunteers. Sixty-two (62) high school students enrolled in home economics volunteered to complete the student surveys. We also sent surveys home to parents of the 62 students who participated, and 60 of those surveys were returned (~97%). In addition, all food services workers (n = 13) completed surveys regarding perceived barriers to vegetable preparation and consumption from their perspective. During the recipe development phase, a professional sensory scientist from the sponsor conducted two focus groups with 33 student volunteers during the participating high school’s study hall period.

For the taste tests, we recruited volunteers from the high school lunch periods during Fall 2016. We planned on a sample size of ~100 students per taste test to ensure adequate power, although we did not perform an *a priori* power analysis. Informational media (i.e., rotating slides of digital display boards, paper fliers, and verbal announcements during the lunch periods) was used to inform students about the project and provide instructions for the vegetable taste testing process.

Students, staff, and parents who participated in the survey phase were each compensated with \$20 for their participation. For each taste test, students were compensated for their participation with a \$5 coupon to use in the school’s snack line. Implied informed consent was obtained in lieu of written consent given the minimal risk, and professional staff in the Penn State Office of Research Protections reviewed all protocols and declared it exempt from full Institutional Review Board review (IRB #1682). No forms of identification were collected from participants.

2.3. Phase I – questionnaires

To understand current trends in consumption, student vegetable preferences, and previous herb and spice exposure, we surveyed food service workers and students enrolled in the school’s home economics program, as well as their parents. We targeted only the home economics courses for the pilot surveys to specifically attain feedback from students who might have an interest in food and improving recipes in the cafeteria. Because there were no available instruments to investigate barriers to herb and spice intake, we developed questionnaires and assessed face validity in the lab. A 17-item questionnaire (see Supplementary Fig. 1) was evaluated by students with the most relevant questions reported here. The first asked students to answer “When you think about school meals, how important are each of the areas below?” with responses ranging from “very important,” “moderately important,” “not very important,” or “Don’t know/Don’t have an opinion.” Students

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