

Providing Salt-Free and Sugar-Free Seasoning Blends to Adolescents and their Effect on Vegetable Intake in the School Environment

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Abstract

Objective: To evaluate the effect of providing sugar-free, salt-free spice blends on vegetable intake among adolescents

Design: Quasi-experimental, case-control

Methods: Subject selection, consumption, and enjoyment of vegetables served in school-offered meals was measured prior to the intervention period and again following 4 weeks of providing spice blends. Measurements were made using numerical and Likert scales along with open-ended solicitation of feedback.

Setting: South Jefferson High School, Adams, New York

Participants: High school students enrolled in health classes in the 2023-2024 school year (n=13).

Intervention: Following a pre-test assessment, students were provided with optional spice blends in the lunch lines for 4 weeks. After the 4 weeks, a post-test was administered to measure the effect of the spices on vegetable selection, consumption, and enjoyment.

Results: After 4 weeks, the spice blends did not produce significant changes in vegetable selection, consumption, or enjoyment among subjects.

Conclusions and Implications: Herbs and spices have been demonstrated elsewhere to be effective methods for improving vegetable intake in the adolescent population.^{22,23} This study's results suggest the need for further, more rigorous testing in the population.

Introduction

Vegetable intake is lacking in Americans.¹ Specifically among teenagers, vegetable intake fails to meet recommendations included in the dietary guidelines for Americans.^{2,3} Such findings are echoed by food service staff at South Jefferson High School in Jefferson County, New York. Low vegetable intake is independently associated with poorer health in adulthood and increased risk of certain chronic diseases.^{4,5,6} This association highlights the importance of investigating strategies to increase vegetable intake among adolescents.

Americans, and specifically children and adolescents, cite inability to guarantee pleasant taste as a barrier to and determinant of vegetable acceptance and intake.^{7,8} Salt in the form of sodium chloride (NaCl, table salt) is often consequentially added to vegetables in preparation by manufacturers and in service by consumers to improve the perceived taste sensation.⁹ While the majority of dietary sodium comes from processing and has functional benefits beyond taste and flavor, at least 10% of estimated total sodium intake is added in cooking and at the table.^{9,10,11} Adding table salt increases risks of chronic diseases like hypertension and heart disease.¹² Consuming whole, fresh fruits and vegetables is ideal, but reducing total daily sodium intake by removing salt added at time of consumption may be viable.

Sugar, like salt, is added to vegetables to increase palatability.⁹ The average American consumes more than the recommended amount of added sugar.¹⁴ Conclusive recommendations regarding added sugars and evidence in support of such conclusions has proven elusive, but some data do suggest increases in negative outcomes with increased added sugar consumption.^{15,16,17,18} Evidence does suggest, however, that added sugars contribute to caloric surpluses and weight gain, which does increase the risk of several cardiometabolic conditions.¹⁹

These data highlight the importance of increasing vegetable intake among adolescents without contributing to added sugar or excess sodium intake. Present literature suggests a positive effect of seasonings on vegetable acceptability.^{19,20,21} Limited research does suggest the potential benefit among adolescents when herbs and spices are introduced across urban and rural demographics.^{22,23} The present study aims to assess the impact of providing salt- and sugar-free seasoning blends to high school students in northern New York. A quasi-experimental study was conducted at South Jefferson High School, offering salt-free and sugar-free herb and seasoning blends to high school students for use in the lunch line to assess the efficacy of providing these herbs and spices as a method of improving vegetable acceptance and intake among adolescents.

Methods

Overview: Setting, Participants, and Recruitment

The study was conducted in a high school in a low-income district in upstate New York.^{1,2} The proposed subjects were high school students enrolled at South Jefferson Central School in grades 9-12, approximating ages 13-18. Given that adolescents represent a vulnerable population, approval was sought from the SUNY Oneonta Institutional Review Board (IRB). The proposed intervention was submitted for review in January of 2024 and received approval on February 7, 2024. Following IRB approval, subjects were recruited in February 2024. Recruitment occurred in regularly scheduled health classes, wherein consent forms were sent home with students and asked to be returned. ($n=47$). Once returned, assent forms were reviewed in health classes by the researcher, and students signed in the presence of the health teacher. Following this process, the subject pool was defined as $n=13$. A brief overview of the study took place, informing students prior to their assent of what was to occur in the study. If either consent, or assent following consent, were denied by students or legal guardians, no data were collected through the course of the study.

Study Design

The health belief model was selected because the inability to guarantee positive taste perception was considerable as a perceived barrier to behavior change. To follow students' attitudes toward vegetables,

their sensitivity to the offered spice blends, and perception of taste as a barrier and gateway to vegetable consumption, a quasi-experimental design was chosen wherein all subjects were offered salt-free and sugar-free spice blends. To first determine baseline in-school vegetable consumption habits, subjects were asked to complete a 3-question pre-test. Following the intervention period, subjects completed a 5-question post-test. In addition to pre- and post-tests, mealtime observations were conducted to better ascertain student attitudes toward vegetables offered as well as the spice blends. Spice blends were then offered in the school lunch line and introduced to students who were interested in trying them.

Intervention and tools

Pre-test

Recruited subjects were given a qualitative and quantitative survey examining: 1.) Rates of vegetable selection in school meals, 2.) Rates of 100% vegetable consumption, and a Likert scale assessing enjoyment of vegetables offered in school. Pre-tests were administered during the subjects’ regularly scheduled health classes. The pre-test was created by researchers and was not previously validated (see Supplemental Figure A)

Spice Blends

Students in the lunch line were offered the opportunity to test versions of spice blends prior to the intervention period for ingratiation of the researcher and to ascertain taste preferences of students. Spices were modified according to these preferences to promote use. Three salt- and sugar-free seasoning blends were offered. The ingredients and profiles are listed in **table 1**.

Table 1: *Spice blends offered as part of the In-School Vegetable Consumption of Adolescents intervention.*

Blend 1: “Spartan’s House Blend” <i>(All purpose)</i>	Blend 2: “Smoked Spartan” <i>(Smoky-sweet)*</i>	Blend 3: “Blackened Gold” <i>(Spice and citrus)</i>
Onion	Chili powder	Garlic
Garlic	Cayenne	Onion
Paprika	Ground cumin	White pepper
Mustard powder	Onion	Black pepper
Salt-free lemon pepper	Smoked Paprika	Cayenne
Basil	Spanish paprika	Thyme
Oregano	Oregano	Oregano
Parsley	Salt-free lemon pepper	
Thyme	Sucralose*	
Dill		

(*) Sucralose was included for the perception of sweet without adding nutritive sweetener.

Final spice blend implementation

Spices were made available in both of the school’s lunch lines. Line 1 entrees were less customizable than line 2, which offered wraps and salads. Students were informed on the first day of the intervention that the spices were available. Spice blends were labeled with school-themed names (**Table 1**) and had ingredients listed. Questions were answered and encouragement was provided on the first day of the intervention to try the blends on different vegetables offered by the school. For the remainder of the intervention period, students were permitted to use the blends in the lunch lines.

Post-test

Following four weeks of provision of the spice blends, a post test was administered in which subjects described the frequency of vegetable selection and intake as well as assessed enjoyment of the spice blends to school lunches. The post-test additionally solicited feedback on how students used spice blends and further steps the school could take to improve school lunches and rates of vegetable consumption. Post tests were administered within the subjects' regularly scheduled health classes. The post-test administered by the researcher was not validated prior to the study (**Supplemental Figure B**).

Mealtime Observations

Students were encouraged to try spice blends and recommendations were made based on foods served as to which blend may provide the best taste experience.

Data Analysis

Data analysis aimed to objectively assess any differences in vegetable selection and consumption for subjects before and after spice blend implementation for significance. This would determine whether provision of spice blends significantly impacted either metric.

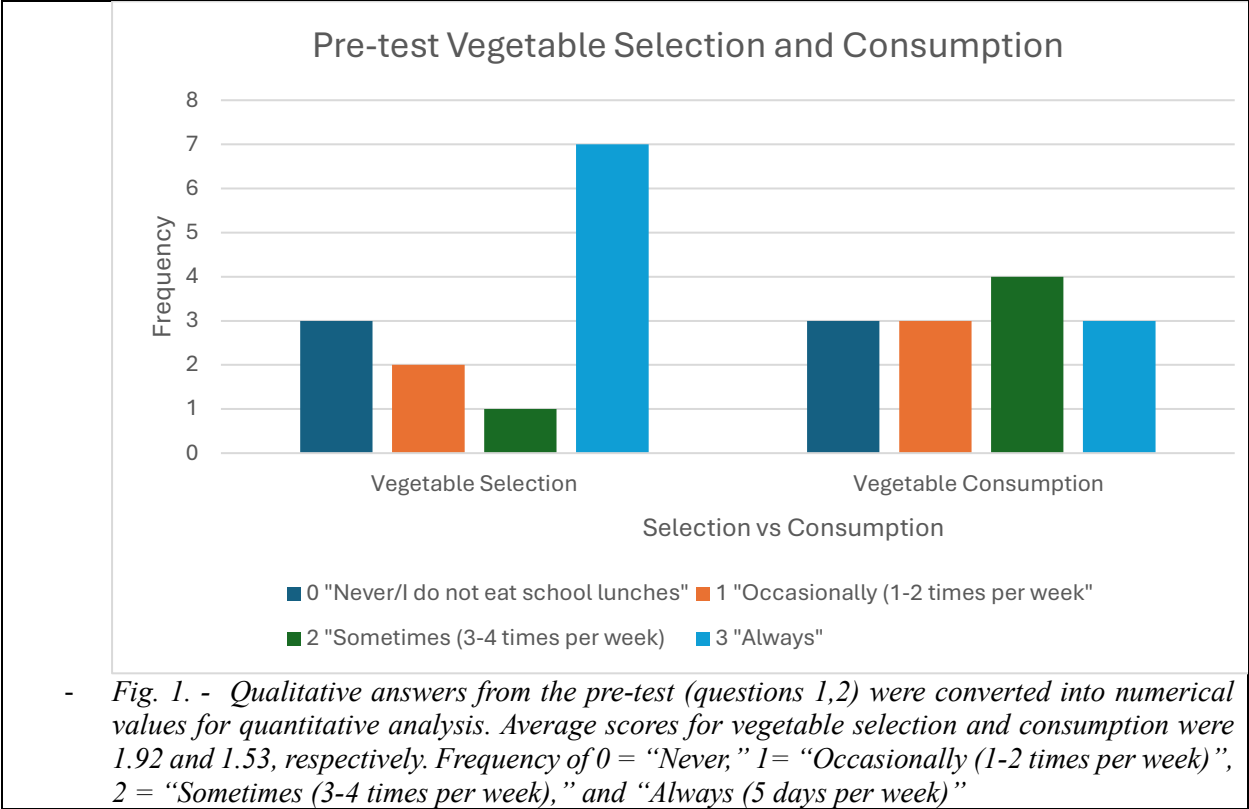
Pre- and post-test data were compiled, assigning numerical values to questions 1 and 2 (never = 0, sometimes = 1, occasionally = 2, always = 3). As question 3 provided data from a Likert scale, the numerical value selected by subjects was quantified in the analysis. Subjects served as their own comparison group. The sample size of $n=13$ did not allow for an assumption of normality, prompting a test for normality. Due to a lack of normality in the sample, Wilcoxon signed rank tests were utilized to test for statistical significance. Questions 4 and 5 of the post-test were analyzed for modal contributions. To determine significance, a p -value <0.05 was considered significant. Statistical analyses were performed using SPSS version 28.01.01.

Results

Recruitment and Pre-test

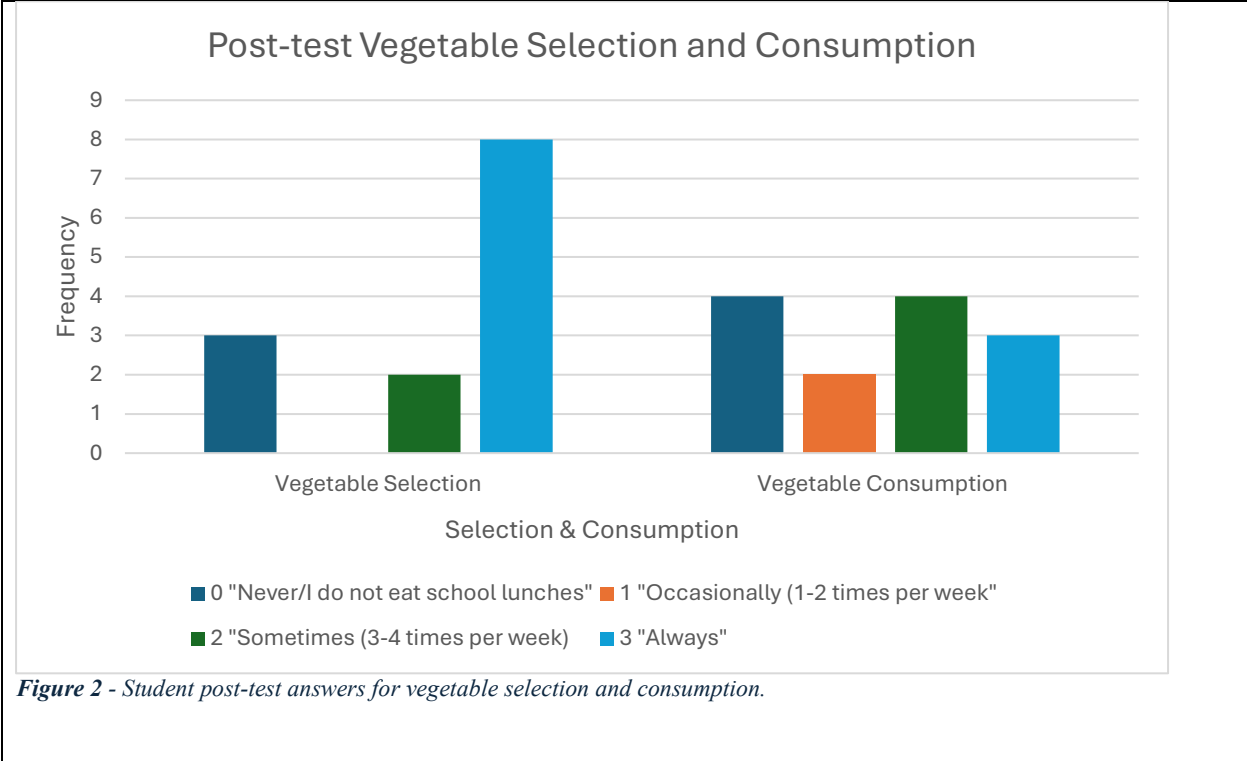
Of those students recruited initially ($n=47$), 13 students returned signed consent forms and assented to participate in the study. Due to incomplete data caused by students' lunch habits (non-participation in school-offered meals), 11 sets of complete information were available from pre-test administration. Demographic data were not formally collected due to potential for disclosure of sensitive information beyond the scope of the study. For those students responding that they never ate school lunch, answers provided were included in the analysis as these students were able to provide feedback relating to what would persuade them to participate in school lunches. Pre-test selection and consumption responses are visualized in **Figure 1**. Student answers for selection averaged 1.9 while consumption averaged 1.5. Average vegetable enjoyment scores in the pretest were 61%.

Figure 1 – Pre-test results relating to Vegetable selection, consumption in school-offered meals.



Post Test

Subjects completing the post-test reported an average vegetable selection and consumption rate of 2.2 and 1.5, respectively, (**Figure 2**) and average enjoyment scores in the post test were 66%. No students were lost over the course of the intervention period.



Effect Analysis of Spice Blends

Data were tested for normality using SPSS 28.01.0. Skewed data reflecting non-normality resulted in the use of non-parametric analysis; for this, analysis was conducted using a Wilcoxon signed rank test.

Data were tested for significance against a 95% confidence interval ($\alpha=0.05$). Pre- to post-test differences in vegetable selection rates were insignificant ($p=0.414$). Pre- to post-test differences in vegetable consumption were similarly insignificant ($p=0.655$). Enjoyment scales pre- to post-test were also insignificant, though by a smaller margin ($p=0.087$). Average pre- and post-test consumption and selection are compared in **Figure 3** and **Figure 4**. A discussion of vegetable selection rates is not warranted as

selection is a requirement for reimbursement in the National School Lunch Program. Average vegetable consumption rates decreased by 5%. Vegetable enjoyment rose by 5% (**Figure 5**).

Students were observed to frequently utilize spice blends initially congruent with recommendations, with subsequent use of a preferred blend regardless of pairing suggestion. Throughout the intervention period, some students remained prohibitively ambivalent.

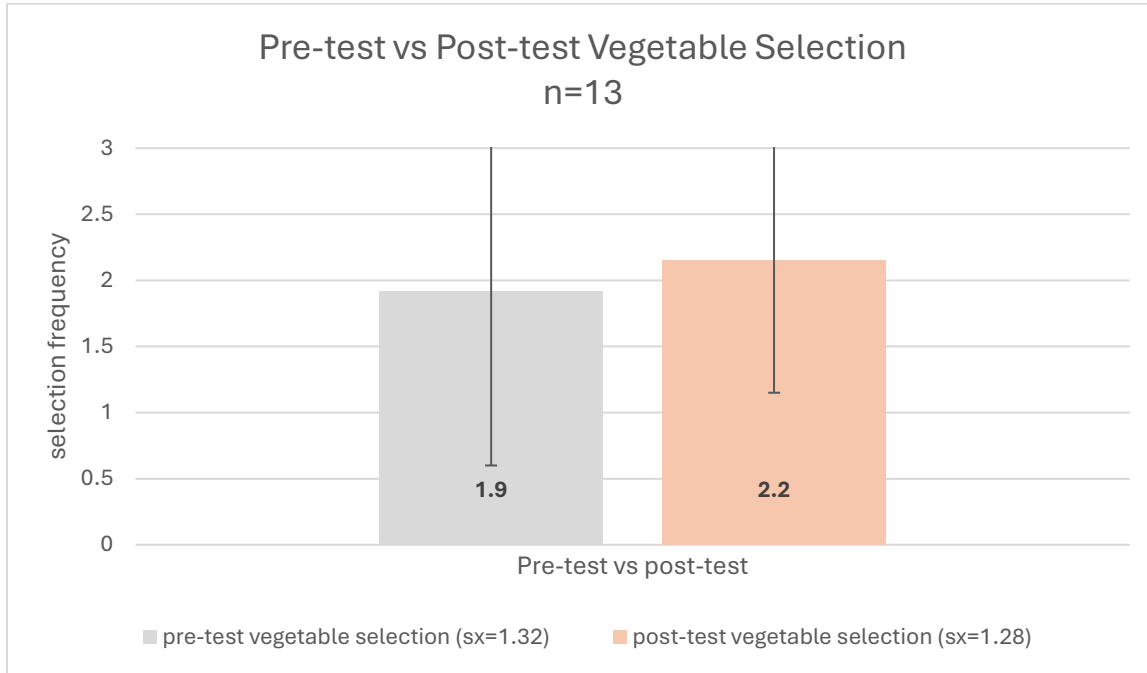


Figure 3 - Comparison of pre- and post-test vegetable selection by students.

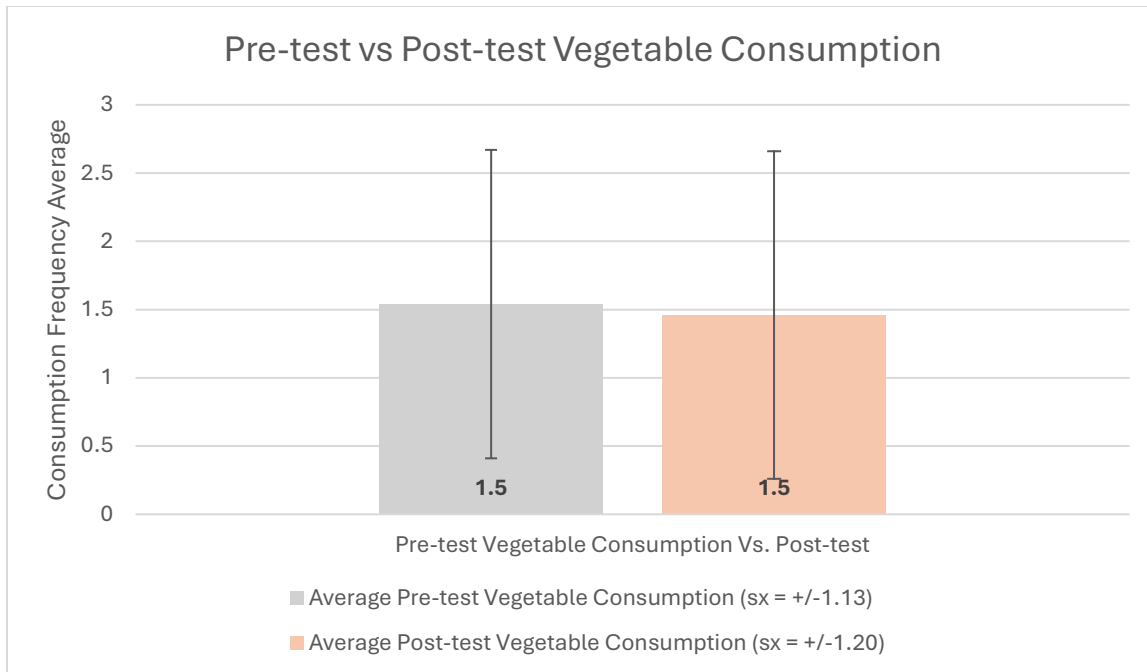


Figure 4 - Pre- and post-test vegetable consumption frequencies. The sample standard deviation for pre- and post-tests were 1.13 and 1.20, respectively.

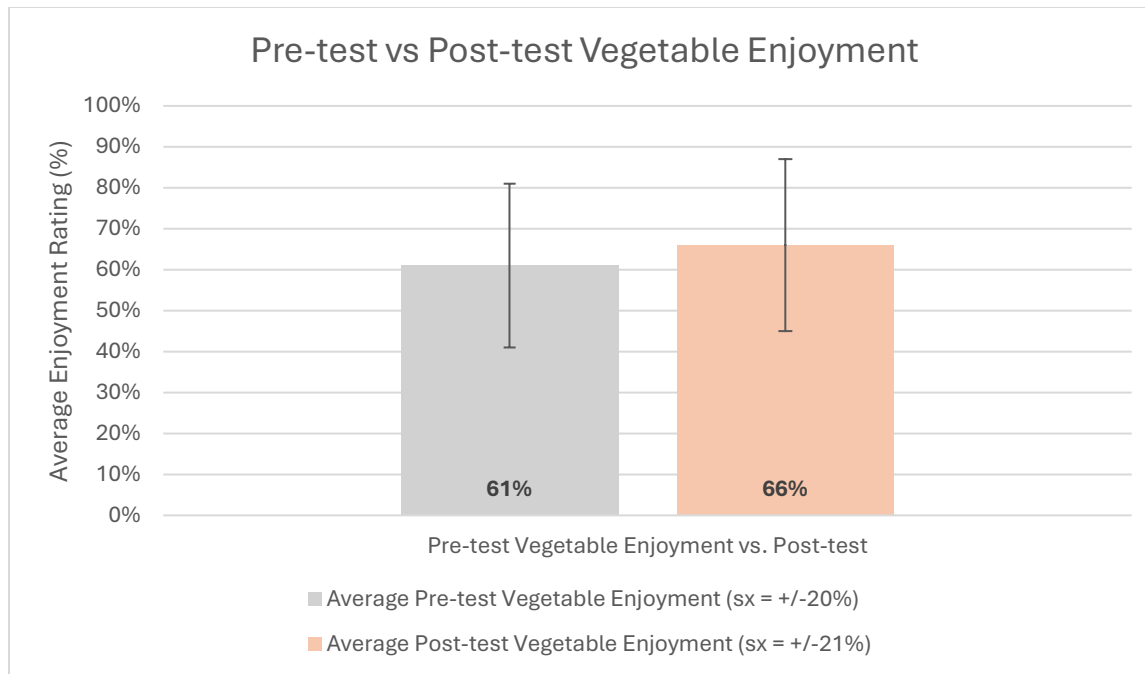


Figure 5- Pre- and post-test vegetable enjoyment. Students utilized a Likert Scale to provide subjective ratings, which were expressed as a percentage.

Qualitative Results from Open-Ended Feedback & Lunch Line Observation

Students more frequently reported utilizing spice blends on offerings in the school’s second lunch line, which offered greater customization and more fresh vegetables (single-serving bags of cucumbers, bell peppers, tomatoes, celery, and carrots). They also had a salad bar, offering even greater degrees of choice and customization in foods with greater overall vegetable provision. These students expressed strong liking for using spice blends on salads. Students in the first line (receiving main entrees with vegetable sides) more often used the blends on the entrees and not on vegetables. Some students were observed in the lunch line regularly using spice blends on soups, which may contribute indirectly to greater vegetable intake, but dependent on soups offered, could increase sodium and saturated fat intake. Most students made comments regarding the desire for vegetables to be prepared differently. The word most often used in feedback was, “soggy,” appearing in over half of subjects’ feedback and frequently in lunch-line observations.

Discussion

Provision of salt-free and sugar-free spice blends over a four-week period was not associated with significant changes in vegetable selection, vegetable consumption, or overall vegetable enjoyment among subjects. These data contradict earlier studies demonstrating the positive effect of herbs and spices on vegetable consumption, particularly among school-age children and within NSLP parameters.¹⁹⁻²³ Prior studies among rural and urban adolescents supported the use of herbs and spice blends as a measure of increasing vegetable consumption.^{22,23} Among subjects, the two most common uses for the spice blends were salads and pizza. Displacement of high-fat, high-salt sauces and salad dressings is possible though not

confirmed by the present study and may be exploratory in future research. Data obtained from subjects was suggested to contradict the overall student body attitude toward the spice blends.

There were multiple weaknesses for the present study. Statistical analysis was limited by a very small subject pool (n=13) out of the initial recruitment pool (n=47) and the overall student body at South Jefferson High School (n>400). The short intervention period of four weeks represents another weakness and feeds another in that students may have been affected by observation and recalled the intent of the study, potentially swaying answers provided in the post-test. This limited the internal validity of the study. The study was further weakened by a lack of data related to plate waste. Measuring plate waste may have granted a more in-depth and accurate view of the true rates of vegetable consumption among the student body overall, rather than relying on self-report from the limited subject pool. The case-control, quasi-experimental design may also be considered a weakness in the context of observer effect. Finally, the intervention period of 4 weeks is short. In combination with plate waste data facilitating less-overt observation, a longer intervention period may have allowed for extinction of students' awareness of the study and led to more accurate self-reporting data.

A significant strength of the study was buy-in from food service staff, teachers, and faculty at South Jefferson Central School. Staff members were welcomed to test the spices in the lunch line and may have provided modeling behaviors in the form of using spice blends on vegetables purchased in the lunch line. Overall, the presence of the primary researcher may have been too significant of a confounding variable.

This study found that addition of salt- and sugar-free spice blends did not significantly impact vegetable consumption among adolescents at South Jefferson. The present study and its conflict with prior literature underscored the need for further, more rigorous testing of the addition of salt-free herbs and spices with an aim of increasing vegetable consumption among adolescents given the recently proposed reductions in sodium and added sugar per meal by the USDA, to be phased between 2025-2027.^{22,23,24}

Conclusion

Provision of salt-free and sugar-free spice blends to high school students did not produce significant changes in vegetable selection, consumption, or enjoyment among high school students. Open-ended feedback regarding spices was generally positive with students reporting further desire for differences in preparation methods. The study was limited by a short intervention period and weak statistical power. Further studies examining adolescents' vegetable intake behaviors in the school setting are warranted given impending changes regarding the reduction of sodium and added sugars in meals reimbursable by the USDA.

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Appendix

Supplemental Figure A

Pre-test Form

Directions: Please fill out this assessment by placing an X on the line next to your answer. For those questions providing numerical scales, please circle the number based on the scale provided.

- 1.) At present, how often would you select vegetables during the school week with school offered meals?

never/I do not eat school lunch

sometimes (3-4 times per week)

occasionally (1-2 times per week)

always

- 2.) At present, how often would you consume 100% of the vegetables you selected with school-offered meals?

never/I do not eat school lunch

sometimes (3-4 times per week)

occasionally (1-2 times per week)

always

- 3.) On a scale of 1 to 10, with 1 being "not at all" and 10 being "extremely," how much do you enjoy vegetables that are offered with school lunches?

1 2 3 4 5 6 7 8 9 10

Supplemental Figure B

Post-test form

Directions: Please fill out this assessment by placing an X on the line next to your answer. For those questions providing numerical scales, please circle the number based on the scale provided.

- 1.) Following the addition of spice shakers, how often would you select vegetables during the school week with school-offered meals?
- | | |
|--|--|
| <input type="checkbox"/> never/I do not eat school lunch | <input type="checkbox"/> occasionally (1-2 times per week) |
| <input type="checkbox"/> sometimes (3-4 times per week) | <input type="checkbox"/> always |

- 2.) Following the addition of spice shakers, how often would you consume 100% of the vegetables you selected with school-offered meals?
- | | |
|--|--|
| <input type="checkbox"/> never/I do not eat school lunch | <input type="checkbox"/> occasionally (1-2 times per week) |
| <input type="checkbox"/> sometimes (3-4 times per week) | <input type="checkbox"/> always |

- 3.) On a scale of 1 to 10, with 1 being "not at all" and 10 being "extremely," how much did you enjoy the addition of spice shakers to school lunches?

1 2 3 4 5 6 7 8 9 10

- 4.) Please indicate on the lines below how you used the spice shakers. On what foods did you use them? How would you have liked to use them? Are there any additional spices/toppings you would have enjoyed being able to use?

- 5.) What further changes would you like to see and/or what would you have liked to see instead of spice shakers to make school lunches more enjoyable, and to make you more likely to consume vegetables with lunch?
