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A Pilot Study to Compare a Mushroom-Soy-Beef Burger to an All-Beef Burger in School Meals

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ABSTRACT

Purpose/Objectives

The purpose of this study was to determine if mushroom blended recipes are an acceptable option for use in the school food program. The palatability and acceptance of mushroom-soy-beef blend burgers among school-aged children was tested.

Methods

Students in grades 2 through 8 were invited to participate in a taste test. Students who volunteered tasted two burger types: regular beef and mushroom-soy-beef "blend" burgers. Burgers were served in random order and were not labeled by type. An interviewer-administered survey included measures to assess palatability and acceptability and included closed and open-ended questions.

Results

Thirty-seven students participated in the taste test. The average age was 10.1 years (range: 7 – 13). Mean scores for acceptability and palatability were similar for both burger types. Students indicated taste as a key driver of burger preference.

Applications to Child Nutrition Professionals

This study demonstrated a comparable palatability and acceptance of the blended burger and the beef burger. These data can be utilized to demonstrate the advantages to schools considering adding mushroom-blend burgers to their menus as a lower calorie, lower fat burger option.

Keywords: taste test; energy density; palatability; food preference; school lunch program

INTRODUCTION

Over 30% of children and adolescents (ages 2 through 19) in the United States are overweight or obese (Ogden, Carroll, Kit, & Flegal, 2014). The rise in obesity prevalence in children over the past two decades in the U.S. has been accompanied by an increase in high energy density (ED in kcal/g) foods in the nation's food supply, and epidemiologic evidence suggests overconsumption of high ED foods is associated with higher daily energy intake, higher body mass index, and obesity risk (Drewnowski, 2004; Mendoza, Drewnowski, Cheadle, & Christakis, 2006). Research is needed to determine the most effective ways to reduce dietary ED, and schools provide an ideal setting to impact children and adolescents' dietary intake, as over 30 million students participate in the National School Lunch Program (NSLP) each day (U.S. Department of Agriculture [USDA], Food and Nutrition Service [FNS], 2013).

Dietary quality of school meals and students' nutritional intake have been highlighted as areas in need of improvement, particularly the excess of calories and saturated fat (Institute of Medicine, 2009; Clark & Fox, 2009; Gordon et al., 2009; USDA & U.S. Department of Health and Human Services [USDHHS], 2015). As part of the continued effort to combat childhood obesity in America and improve nutritional quality of school meals, new school meal standards were released in January 2012. These requirements include increasing servings of fruits, vegetables, and whole grains, higher levels of protein, vitamin A, vitamin C, calcium, and iron, while limiting saturated fat, *trans*-fat, cholesterol, added sugar, and sodium (USDA- FNS, 2012). Further, the Scientific Report of the 2015 Dietary Guidelines Advisory Committee identifies a healthy dietary pattern as lower in red and processed meat (USDA & USDHHS, 2015).

A potential strategy to improve school meal nutritional quality is to partially substitute higher ED meat with lower ED ingredients in recipes. Some, but not all, previous research has demonstrated that school lunch recipes made with partially substituted lower ED ingredients, such as soy-based ingredients, are accepted by students and improve nutritional quality (Ashraf, Schoeppel, & Nelson, 1990; Endres, Barter, Theodora, & Welch, 2003; Klein, 2006; Thomas & Lutz, 2001). Mushrooms as a substitution in meat-based recipes have the potential to be a viable option among students and help lower the fat and caloric composition of school meals while maintaining adherence to school meal regulations.

Mushrooms are a low ED food with the most common forms in the American diet providing 24 - 31 kcals and 0.2 - 0.34 grams of fat per 100 grams (Feeney et al., 2014). In addition to reducing energy intakes, the sensory qualities of mushrooms, including the texture and umami taste, may contribute to the utility of a meat-mushroom blend (Feeney, Myrdal Miller, & Roupas, 2014; Myrdal Miller et al., 2014). Previous studies investigated how substituting white button mushrooms for beef in a test lunch in the short-to-intermediate term affected energy intake, palatability, appetite, and satiety in normal weight, overweight, and obese adults. Energy intakes were significantly higher during meat lunches than mushroom lunches, and there was only partial energy compensation for this difference over four days. Total daily energy intake was also significantly greater on the meat days, while ratings of palatability, appetite, satiation, and satiety did not differ significantly (Cheskin et al., 2008). A more recent study found an advantage to mushroom substitutions on a longer-term basis in adults (Poddar et al., 2013). These results strongly suggest that the substitution of low ED mushrooms for high ED foods such as beef can be an effective method for reducing total daily energy intake.

Previous research suggests that the concept of blending higher ED ingredients with lower ED ingredients could be applied to a popular commercial item and tested in the school setting as a method to improve nutrient intake among children. This pilot study builds on the experimental results above to test the palatability and acceptance of mushroom-soy-beef blend burgers among school-aged children. Researchers sought to determine student acceptability of the blend burger for use in the school food program prior to developing a full scale operational intervention.

METHODOLOGY

Sample and Procedures

The study procedures consisted of a taste test comparing two burger versions (traditional beef burger (JTM Food Group, n.d.- a) versus a mushroom-soy-beef "blend" burger (JTM Food Group, n.d.- b) (Table 1). While the beef burger's primary ingredient is ground beef, the blend burger's primary ingredients are ground beef, mushrooms, and textured vegetable protein. A Baltimore City Public School System Registered Dietitian provided input into the study design and was on site during test testing, ensuring that the burger products and preparation methods were consistent with the school district's existing product availability and protocols.

One Baltimore City elementary/middle (Pre-K - 8th grade) public charter school participated in this study and was recruited based on a prior relationship with a study team member. The school administrators provided assistance in scheduling and recruitment and access to their kitchen and cafeteria facilities. All children in grades 2-8 who participated in the after-school program were invited to participate.

Table 1. ***Nutrient Comparison Between Blend Burger and Beef Burger***

	Blend Burger	**Beef Burger**
Serving Size (ounces)	2.46	2.45
Calories	129	176
Protein (grams)	12	12
Carbohydrates (grams)	2	3
Total Fat (grams)	8	12
Saturated Fat (grams)	3.1	4.8
Trans Fat (grams)	0	0.8
Cholesterol (milligrams)	32	49
Sodium (milligrams)	215	279
Fiber (grams)	1	0
Iron (milligrams)	1	1

A double-blinded taste test was performed in randomized order of presenting the two burger types, labeled as "Burger A" and "Burger B." The school's cafeteria manager prepared both burger types, following the school's nutrition service standard procedures and as recommended by the manufacturer (cooked in steamer to preserve moisture). Interviewers administered the

taste test to each student individually. One half of a 2.45 ounce burger of each variety was served, each on one half of a hamburger roll. Condiments (ketchup and mustard) were offered. In order to cleanse the palate, the student was asked to drink a little water and then wait approximately two minutes, timed by the interviewer (Skokan, Junkins, Corneli, & Schunk, 2001). Burger 1 ("A" or "B" depending on order of randomization) was then placed before the child with instructions to eat as much as desired, but at least one bite. After the student tasted Burger 1, the interviewer administered survey questions to assess acceptability of Burger 1. The student was then asked to drink water and then taste Burger 2, given the same instructions as for Burger 1. After the student tasted Burger 2, the interviewer administered survey questions to assess acceptability of Burger 2, followed by survey questions to assess preference for Burger 1 or Burger 2.

Data collection was completed on a single day in November 2014. Parents provided written consent, and students volunteered and provided oral assent to participate. Students received a $10 gift card for their participation. The study procedures were reviewed and approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board, and the Baltimore City Public Schools System Office of Research and Accountability.

Outcome measures

Demographic variables including age, gender, and grade level were collected. The survey also consisted of questions on palatability, acceptability, and preference.

Palatability and Acceptability. Students completed a 7- point Hedonic Facial Scale (grades 2- 5) or a 7-point Likert scale (grades 6- 8) to assess acceptability, including flavor, appearance, texture/consistency, tenderness/juiciness, smell/aroma, and overall satisfaction with the burger.

The Food Action Rating Scale (FACT) is a 9-point rating scale which has been used in multiple consumer preference studies (Aliani, Ryland, & Pierce, 2012; Jones et al., 2014; Ludy & Mattes, 2012; Schutz, 1965). A modified version of the FACT, using a 5-point rating scale, was administered to determine the children's perceptions of acceptability. The modified FACT scale values were as follows: 1= "I would eat this only if I were forced to"; 2= "I would hardly ever eat this"; 3= "I would eat this if available but would not go out of my way"; 4= "I would eat this very often"; 5= "I would eat this food every opportunity I had."

Preference. To determine burger preference the following question was asked: "If each of the burgers you just ate was offered next week in your school cafeteria, and you had to choose one, which one would it be?" Open-ended questions were as follows: "What about your first choice of burger did you like?" and "What about your second choice did you dislike?"

Data Analyses

Using Stata Version 11, mean scores on the Hedonic Facial Scale or Likert scale and FACT ratings were compared for significant statistical differences between the two burgers.

RESULTS AND DISCUSSION

Thirty-seven students (20 girls, 16 boys, 1 gender not recorded) with an average age of 10.1 years (range: 7 -13 years) participated in the taste test. Two students declined participation.

Outcome Measures

Palatability and Acceptability. There were no differences in mean acceptability scores for flavor, appearance, texture/consistency, tenderness/juiciness, smell/aroma, and overall satisfaction between the beef burger and blend burger (Figure 1). Beef burger and blend burger FACT ratings were also not significantly different (3.8 vs. 3.6, p-value: 0.80).

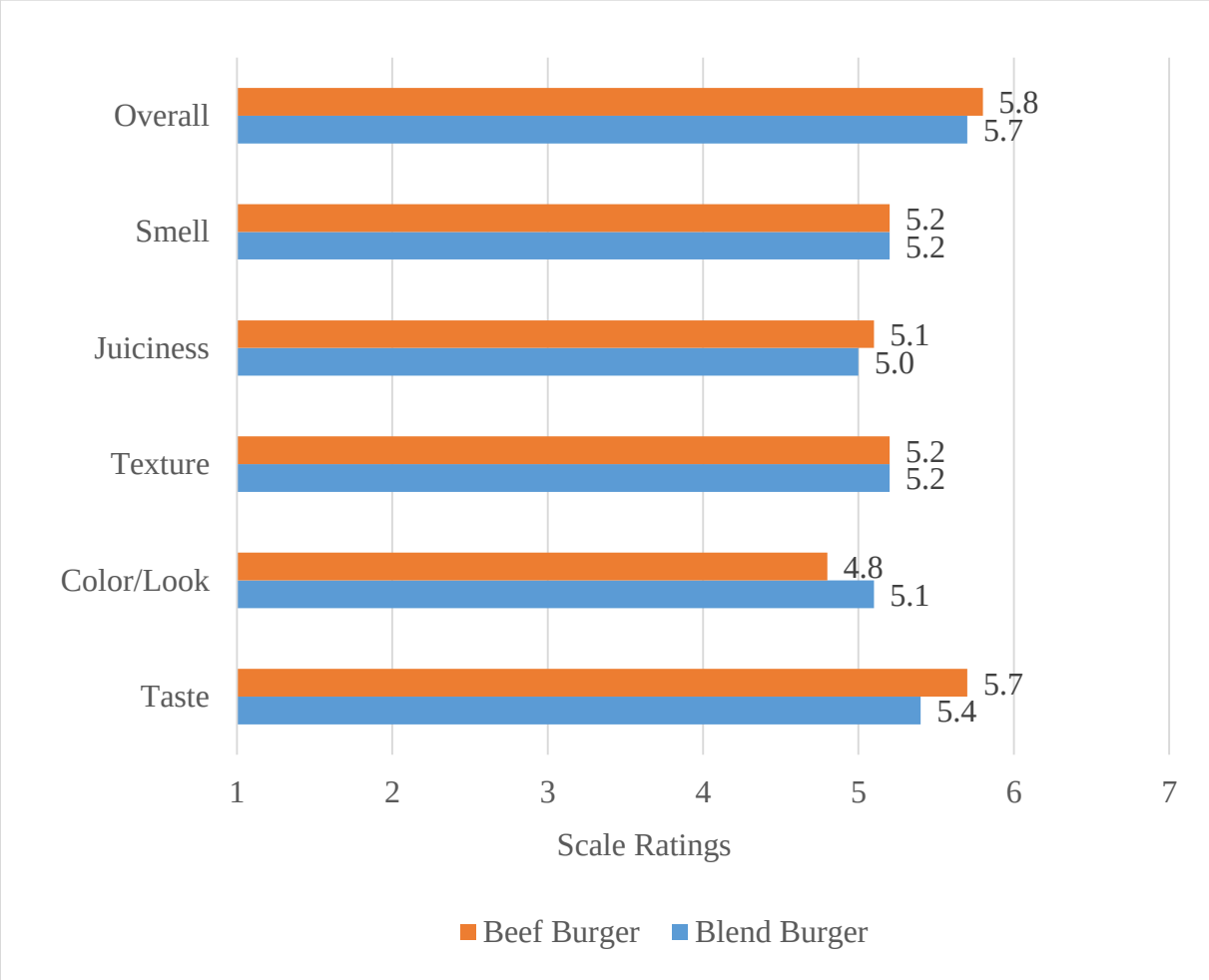

Figure 1. ***Burger Acceptance Ratings Among Students Participating in a Taste Test of Blend burgers and Beef Burgers (n= 37)***

Preference. When asked which burger they would choose if it were offered next week in the school cafeteria, 14 (37.8%) students chose the blend burger and 23 (62.2%) chose the beef burger (Table 2). The blend burger was preferred over the beef burger by 35.0% (n= 7) of girls and 43.7% (n= 7) of boys; however, there were no statistically significant differences in burger preference observed based on gender (p= 0.593). The majority (75.0%, n= 12) of students aged

10 and older preferred the beef burger over the blend burger (Table 2). No statistically significant differences in burger preference were observed based on age (p= 0.160).

Table 2. ***Burger Preference Among Students Participating in a Taste Test of the Blend Burger and Beef Burger by Age and Gender*** *(n= 37)*

	n	Blend Burger	Beef Burger	*p*-value
All	37	14 (37.8%)	23 (62.2%)	
Gender [a]				0.593
Female	20	7 (35.0%)	13 (65.0%)	
Male	16	7 (43.8%)	9 (56.3%)	
Age				0.160
≤ 10 years	21	10 (47.6%)	11 (52.4%)	
≥ 10 years	16	4 (25.0%)	12 (75.0%)	

[a] One student with no response to gender: preference response was beef burger

Among the 14 students who choose the blend burger as their first choice, 11 student responses were related to taste when asked, "What about your first choice of burger did you like?" For instance, *"Tastes good, didn't taste nasty."* Other common answers were related to texture. For instance, *"[It had] more flavor and it had a soft texture when I chewed it."*

When 14 students who preferred the blend burger were asked what they did not like about their second choice, the majority (n= 8) of students' responses were related to poor taste. For example, *"Tastes not as good"* and *"It doesn't taste sweet"*.

Among the 23 students who choose the beef burger as their first choice, 17 students also referred to taste. Other common responses were related to texture and juiciness. For example, *"It was more juicier and tasted better"; "Really good flavor like one you'd buy at a restaurant."*

When students who preferred the beef burger were asked what they did not like about their second choice, most students responded with poor taste (n= 12) or poor texture (n=9). For instance *"Really hard to swallow, doesn't have much flavor"* and *"Hard, didn't have much taste."*

Discussion

This study demonstrated a comparable level of acceptance, palatability profile, and satiety value of the two burger types. These data, along with nutritional data on the lower fat and calories of the blended burger, suggest potential advantages to schools considering adding mushroom-blend burgers to their menus.

Through plate waste studies, children in school settings have previously been shown to demonstrate acceptance of recipes partially substituted with lower ED ingredients, specifically soy (Ashraf, et al., 1990; Endres, et al., 2003; Klein, 2006). For example, plate waste data was used to measure the acceptability of both soy-substituted and soy-enhanced products during a four-week period among over 1,000 elementary school students (1^{st} to 6^{th} grade). The researchers found that the percentage of foods consumed was similar for soy-based and traditional entrées, with the exception of "chicken-like" nuggets (Klein, 2006).

In the current study, 62% of students preferred beef burger over the blend burger. Although multiple characteristics, such as texture, juiciness, and appearance were also described as reasons for liking or disliking burger choices, qualitative data indicated that taste is a primary sensory characteristic driving preference, which is consistent with the literature (Glanz, Basil, Maibach, Goldberg, & Snyder, 1998).

Taste preference is influenced by multiple factors, including genetics, social determinants, parental influence, the home food environment, and exposure (Adair & Popkin, 2005; Drewnowski, 1997). Experience with the taste of foods and repeated exposure increases acceptance and preference for selected foods, highlighting the importance of exposure frequency (Cooke, 2007; Lakkakula, Geaghan, Zanovec, Pierce, & Tuuri, 2010; Sullivan & Birch, 1990; Wardle & Cooke, 2008; Wardle et al., 2003). Repeated exposure to beef burgers and the higher fat content could potentially lead to some students preferring the beef flavor over the blended flavor (Birch, 1992).

This study had some limitations. First, a relatively small sample size limited the power to test differences between subgroups, such as age and gender. Second, the study was completed at one school with students who participated in the after school program; therefore, the findings may not be generalizable to students outside of this school program. The participating school also has a consistent history of health promotion. Students are exposed to various foods and nutrition education opportunities through their full-time, on-site food educator, which also limits the generalizability of the study. Third, study participants were self-selected. It is unknown whether the students who participated were more open to new recipes than students who did not participate, or if they had different levels of exposure to mushrooms or soy.

A key strength of the study was the randomized, controlled and blinded taste-testing procedures utilized, which would reduce any bias resulting from knowing which burger contained the mushroom and soy ingredients. Further, the equipment used to prepare the burgers for taste testing was the same that would be used in standard school operating procedures, and was overseen by the school's cafeteria manager.

CONCLUSIONS AND APPLICATIONS

Multiple barriers exist to serving more healthful food options in school settings, including taste and quality of the foods served (Brouse, Wolf, & Basch, 2009; Cho & Nadow, 2004; Gordon et al., 2007; Meyer et al., 2001; Nollen et al., 2007). This research provides support for student acceptability of a burger that is lower in fat and energy density (kcal/gram). While the beef burger provided 2.39 calories per gram, the blend burger provided 1.85 calories per gram. The blended burger tested in this pilot study would allow school nutrition programs to serve a burger

that is a similar portion size, while adhering to school meal guidelines. In addition to increasing exposure to new ingredients, taste tests with students provide the opportunity for students to provide feedback on potential new recipes, and can help increase engagement in school nutrition and the menu planning process.

Future research should include a larger sample size so that differences in preference based on age can be better understood. Studies on cost effectiveness and impact on dietary intake when using mushroom-blended recipes in schools are also needed. Further research is needed to determine the feasibility, acceptance, and satiety when served in the normal school lunch setting, and is the next step in this research.

Based on our findings, mushroom-soy-beef blended burgers have the potential to be an accepted alternative to higher energy density beef burgers among school-aged children. Additional blended recipes for commonly served school menu items, such as meatloaf, meatballs, and meat-based spaghetti sauce should also be considered and explored.

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BIOGRAPHY

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