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The Influence of Herbs, Spices, and Regular Sausage and Chicken Consumption on Liking of Reduced Fat Breakfast and Lunch Items

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Abstract

Adults often consume more fat than is recommended. We examined factors that may improve liking of reduced fat and reduced saturated fat foods, including the addition of herbs and spices and habitual consumption of different high-fat and low-fat food items. We randomized adults to taste three different conditions: full fat (FF), reduced fat with no added spice (RF), and reduced fat plus spice (RFS). Subjects rated their liking of French toast, sausage and the overall meal, or chicken, vegetables, pasta and the overall meal on a nine-point hedonic Likert scale. Overall liking of the RF breakfast and lunch meals were lower than the FF and RFS versions (Breakfast: 6.50 RF vs. 6.84 FF, p=0.0061; 6.50 RF vs. 6.82 RFS, p=0.0030; Lunch: 6.35 RF vs. 6.94 FF, p<0.0001; 6.35 RF vs. 6.71 RFS, p=0.0061). RFS and FF breakfast and lunch meals, French toast, chicken and vegetable likings were similar. FF and RFS conditions were liked more than RF for the breakfast and lunch meals, French toast, chicken entrée and vegetables. Liking of all three sausage conditions were similar. FF Pasta was liked more than RFS and RF (7.47 FF vs. 6.42 RFS, p<0.0001; 7.47 FF vs. 6.47 RF, p<0.0001). Habitual consumption of roasted chicken was associated with reduced liking of FF chicken (r = −0.23, p=0.004) and FF pasta (r = −0.23, p=0.005). Herbs and spices may be useful for improving the liking of lower-fat foods and helping Americans maintain a diet consistent with the US Dietary Guidelines.

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Author Contributions

S. Polsky assisted in the study design and outcomes analyses, conducted some of the study visits, entered study data, wrote the first draft of the manuscript, and designed tables and figures. J. Beck revised the manuscript and formatted the manuscript for journal submission. R. Stark scheduled study participants, conducted study visits, collected data and entered study data for analyses. Z. Pan analyzed the data for the manuscript. J. Hill reviewed and edited the manuscript. J. Peters assisted in study design and reviewed and edited the manuscript.

Keywords

fat; consumer acceptance; composition

Introduction

The *Dietary Guidelines for Americans* recommends that individuals consume 10% or fewer of total calories from saturated fats; however, Americans usually surpass this threshold (Kachan and others 2012; Kris-Etherton and others 2012; USDA & USDHHS 2010). Total fat intake is currently near the upper limit of recommendations (USDA & USDHHS 2010). Elevated total dietary fat intake is associated with excess calorie intake (Hill and others 2000; Johnstone and others 1996; Lissner & Heitmann 1995; Stubbs and others 1996). Furthermore, dietary fat has been found to promote positive fat balance and weight gain under a variety of conditions (Horton and others 1995; Peters 2003; Stubbs and others 1995a; Stubbs and others 1995b; Thomas and others 1992). Despite the recent shift in focus from dietary fat to dietary carbohydrate as a causal factor in obesity (Johnson and others 2007; Malik and others 2010), dietary fat remains a key contributor to positive fat and energy balance (Stubbs and others 1997). Reducing the fat content of foods while maintaining palatability may be a method for improving dietary quality, weight loss and weight loss maintenance success among normal weight, overweight and obese individuals.

Reducing intake of dietary fat and saturated fat is challenging for many individuals. Full-fat versions of foods are often preferred over low-fat versions (O'Quinn and others 2012). Americans consume large amounts of animal fats (such as poultry, beef, and pork) (USDA 2014), which are rich sources of saturated fatty acids (USDA & USDHHS 2010). Consumption of red meat and poultry products has increased steadily since 1965 (USDA 2014). There are numerous factors that influence this increasing consumption of high-fat foods. Biological contributors such as body weight and salivary composition have been linked to higher fat liking (Dressler & Smith 2013; Nakamura and others 2001; Neyraud and others 2012). In addition, low-fat foods are often associated with increased cost and decreased convenience.

The *Dietary Guidelines for Americans* also recommends a balanced plate of food with protein, carbohydrates, and vegetables. However, little is known about how habitual consumption of protein affects the liking of carbohydrates and vegetables consumed in the same meal. In addition, habitual consumption of low-fat versus high-fat protein sources may affect the liking of macronutrients.

Adding herbs and spices to food enhances the flavor of the food. We have previously shown that adding herbs and spices to low-fat meatloaf made its liking not different from that of a high-fat version without herbs and spices (Peters and others 2014). Using herbs and spices to boost flavor of low-fat foods could be a practical, affordable, and effective strategy for helping individuals meet dietary guidelines, improve their nutrition and health, and maintain a healthy body weight.

In this study we examined whether adding herbs and spices to saturated fat and reduced fat breakfast foods (with a sausage item) and lunch foods (with a poultry item) can improve overall consumer liking of food consumed at a single meal occasion. We hypothesized that the addition of herbs and spices would attenuate the reduction in consumer liking that is typically seen with reduced fat foods. We examined whether habitual consumption of sausage (a high-fat protein) affected liking of that food and the full breakfast meal. Our hypothesis was that habitual consumption of sausage would be associated with a preference for the full-fat versions of foods. We also examined whether habitual consumption of a high-fat preparation of chicken (fried) versus a low-fat preparation of chicken (roasted) affected liking of food consumed. Our hypothesis was that habitual consumption of fried chicken would be associated with a preference for full-fat versions of food, while habitual consumption of roasted chicken would be associated with similar liking between full-fat versions and reduced fat with added spice versions of meal items.

Materials and Methods

We examined the overall consumer acceptability of three different breakfast and three different lunch conditions in two separate studies that each used a randomized, three-period, within subjects, crossover design. The three test conditions were (1) full fat (FF), (2) reduced fat (and calorie) with no added spice (RF) and (3) reduced fat (and calorie) plus spice (RFS). The two reduced fat breakfast meals were matched for calories and dietary fat. The two reduced fat lunch meals were also matched for calories and dietary fat. The test breakfast meals were composed of a French toast entrée item and a sausage side dish. The test lunch meals were composed of a chicken entrée item and 2 side dishes: (1) mixed vegetables (broccoli and cauliflower) and (2) creamy pasta (penne). Subjects were blinded to the test meal condition (FF, RF, RFS). These studies were approved by the Colorado Multiple Institutional Review Board at the University of Colorado, Anschutz Medical Campus. All subjects provided written informed consent.

Study power

Based on study by Essed and others (2009), regarding the liking of soup, we conservatively assumed the within-subject variance to be 3.27 (e.g. ICC = 0.55) and the between-subject variance to be 4 to assess power of each study. We targeted enrollment of 150 subjects for each test meal condition and assumed a dropout rate of 20% to obtain 120 subjects per study who completed each condition, allowing a greater than 95% chance to detect statistical significance between FF and RF and between RF and RFS (Ramon C. Littell and others 2006). More detailed methods for determining study power are described elsewhere (Peters and others 2014).

Subjects and screening

Adults18-65 years old were recruited for the breakfast and lunch studies from the University of Colorado Anschutz Medical Campus and surrounding community using online postings and campus announcements. Prospective subjects were screened by completing a brief survey or by a phone call. Subjects that qualified were asked to sign an informed consent. Some subjects participated in both the breakfast and lunch meal studies, but some

individuals participated in either the breakfast or lunch meal study alone. Therefore, there was some overlap in participants between the two studies.

Inclusion/Exclusion criteria

Adults were included if they were between 18 and 65 years old. Adults were excluded if they were diagnosed with sensory or taste disorders that would prevent them from evaluating the food, they were pregnant, had a known eating disorders, had medical conditions that may adversely affect taste (e.g., dysgeusia), had allergies to the test food/ingredients, were unable to complete the protocol, had personal dietary restrictions towards test meal items (e.g., vegetarian), expressed dislike of the particular food items to be served in the test meals, and had a history of missing or rescheduling 2 or more study visits in one of our previous food tasting studies (Peters and others 2014).

Subjects were individually randomized to treatment sequences representing all possible order combinations of the 3 test conditions (FF, RF, and RFS). Randomization was performed using SAS procedure, Proc Plan.

We collected data on relative dietary quality (habitual fat and saturated fat intake) and habitual consumption of sausage and chicken products over the previous year with the 2005 Block Food Frequency Questionnaire (FFQ) (Block and others 1990; Subar and others 2001). Descriptions of the randomization process and the Block FFQ used in this study can be found in Peters and others (2014).

Test meals

All three breakfast test meals were comprised of the same items: French toast and sausage. The full fat version of French toast was prepared with half and half cream. The reduced fat French toast was prepared with whole milk. All French toast conditions were made with the same amount of eggs, sugar, and bread and were served with two teaspoons of maple syrup. The full fat sausage patties were prepared with pork. The reduced fat sausage patties were prepared with half as much pork and the addition of 6% fat and 1% fat ground turkey. Basic herbs and spices were coarse salt (0.02 grams) for FF French toast and salt (0.87 – 0.89 grams), pepper (0.03 – 0.69 grams), and sage (0.056 – 0.19 grams) for all sausage conditions. The reduced fat with herbs and spice version used the same ingredients as the RF version but with additional herbs and spices: for French toast- cinnamon (0.46 grams), nutmeg (0.04 grams), cinnamon extract (0.87 grams), and vanilla extract (0.26 grams); for sausage- rosemary (0.003 grams), thyme (0.003 grams), and red ground pepper (0.01 grams). The quantities of herbs and spices used in the RFS meals contributed negligible calories. Total fat, saturated fat, and total calories for the breakfast test meals are shown in Table 1. In the overall meal, fat reduction resulted in a 15% decrement in total calories and 50% and 42% decrements in saturated and total fat, respectively.

All three lunch test meals were comprised of the same items: chicken, broccoli and cauliflower in butter sauce, and penne with creamy white sauce. The full fat version of chicken was prepared with the skin on. The reduced fat chicken was prepared without the skin. Basic herbs and spices were salt and pepper for all chicken conditions. The reduced fat with herbs and spice version used the same ingredients as the RF version but with additional

herbs and spices: for chicken garlic powder, onion powder, fennel seed, smoked paprika, and parsley granules. Descriptions of the FF, RF and RFS preparation of the mixed vegetables and creamy pasta can be found in Peters and others (2014). Total fat, saturated fat, and total calories for the breakfast and lunch test meals are shown in Table 1. In the overall meal, fat reduction resulted in a 27% decrement in total calories and a 68% and 59% decrements in saturated and total fat, respectively.

Study Procedures

For breakfast test meals, subjects were instructed to not eat any food or drink caloric beverages for two hours prior to seating time on test days. Breakfast test meals were served from 7 to 9 AM and 11 to 1 PM. Subjects were assigned to one of six different “seatings”: 7 AM, 8 AM, 9 AM, 11 AM, 12 PM, or 1 PM. Each seating accommodated 8-12 subjects so that up to 72 subjects could be served each test day. Individual subjects were tested one week apart for each meal and were tested on the same day of the week and the same hour of the day for each of the three test meals.

For lunch test meals, subjects were instructed to not eat any food or drink caloric beverages after 9 AM on test days. Lunch test meals were served from 11 to 1 PM for each study. Subjects participated in one of three different “seatings”: 11 AM, 12 PM, or 1 PM. Each seating allowed 8-12 subjects to participate, resulting in up to 36 subjects being served each test day. Individual subjects were tested one week apart for each meal and were tested on the same day of the week and the same hour of the day for each of the three test meals. Participants were instructed to concentrate on tasting the meal items without other distractions (additional methods regarding study sessions are described in Peters and others (2014). Subjects filled out a nine-point hedonic scale rating instrument (Likert scale) to assess their liking of the overall composite meal, the test entrée, and the test side dish(es) (one side dish for breakfast meal and two side dishes for lunch meal). The Likert scale included nine options ranging from “dislike extremely” to “like extremely”.

Statistics and data analysis

Study data were double data entered into REDCap (Research Electronic Data Capture), which is an internal secure, computerized database system. Discrepancies between the two copies of each subject's records were compared using SAS Proc Compare Procedure. Dietary habits and demographic characteristics of subjects were tabulated using summary statistics. We used chi-squared tests and t-tests to compare characteristics and dietary habits between subjects who participated in the breakfast or lunch test conditions and those who did not. Percent distribution with interquartile range was used to report categorical variables, while continuous variables are reported as means with standard deviations. We used a linear mixed effects model to test differences in liking scores between types of foods. The linear mixed effects model consisted of the test meal period, randomization sequence, and test meal condition as fixed effect predictors and a random subject effect was used. We tested least square estimates of the differences between types of food and the 95% confidence interval for this difference was estimated under the model. The FFQ questions that asked about consumption of different chicken and sausage products asked participants to classify their frequency of consumption into one of nine categories ranging from “never” to “every

day." We felt that a reasonable classification of habitual consumers of a given product would be those who consumed that product at least once monthly, while infrequent consumers of that product would be those who consumed it less than once monthly. We dichotomized frequency of consumption of the products into the two aforementioned categories and conducted t-tests to compare mean liking scores of test meal items between habitual and infrequent consumers of the different chicken and sausage products. The Spearman correlation coefficient was used to calculate the correlation of liking score with frequency of FFQ variables.

Results and Discussion

Breakfast Meal

Between January and May 2013, 151 individuals consented to the study. Among participants who consented, five did not go on to participate in the study or were withdrawn leaving 146 for our final analysis of the breakfast study (96.7%). There were no significant differences in demographic characteristics or FFQ dietary habits between individuals who participated in the study and those who did not (data not shown). Baseline characteristics and dietary habits of breakfast participants are shown in Table 2. Among participants, 69% were women (104/151), the mean age was 36.5 years, and the mean body mass index (BMI) was 24.3 kg/m^2.

Based on the Block FFQ, breakfast participants reported mean consumption of calories consumed as fat and as saturated fat as 36% and 11%, respectively, which are consistent with national United States data sets (Kris-Etherton and others 2012; Wright & Wang 2010). The proportion of total calories consumed as fat and saturated fat of the subject population were not dissimilar from those of the American population as a whole and were higher than national dietary recommendations.

Among the 146 breakfast participants, one participant missed the FF session, two missed the RF session, and one missed the RFS session. The full fat meal without additional spices was well liked overall with a mean liking score of 6.84. Reducing fat in the overall meal caused a significant drop in overall liking (6.50 RF vs. 6.84 FF, $p = 0.0016$, see Figure 1a), while adding herbs and spices attenuated the decline in meal liking scores such that the RFS conditions was not significantly different from the FF condition (6.82 RFS vs. 6.84 FF, $p = 0.8513$). Similar findings were obtained for the French toast entrée (see Figure 1b). Mean Likert scores for the overall meal and individual test meal items are shown in Table 3. Liking scores for both FF and RFS overall meal and French toast were significantly greater than for RF.

There were no significant differences between the liking of the FF, RF and RFS sausage versions (see Figure 1c). Mean consumption of the three meal conditions was 84% of the food provided and there were no significant differences by test meal condition (see Table 3), which suggests that all the meal conditions were generally liked.

The mean Likert scores of each meal item for each test condition as rated by participants who habitually consumed breakfast sausage are presented in Table 4. There were 87 (57.6%)

participants who reported consuming sausage less than once monthly and 57 (37.7%) who consumed sausage one or more times per month. There was no relationship between frequency of sausage consumption and liking of the entire meal, French toast or sausage, regardless of test condition. Participants who ate sausage one or more times per month rated FF, RF, and RFS meals, French toast and sausage similarly to those who ate sausage less than once per month.

Lunch Meal

Between January and April 2013, 152 individuals consented to the study. Among participants who consented, one did not go on to participate in the study and one was withdrawn, leaving 150 for our final analysis of the chicken study (98.7%). There were no significant differences in demographic characteristics or FFQ dietary habits between individuals who participated in the study and those who did not (data not shown). Baseline characteristics and dietary habits of participants are shown in Table 5. Among participants, 70% were women (106/152), the mean age was 36.6 years, and the mean body mass index (BMI) was 24.3 kg/m^2. Participants reported mean consumption of calories consumed as fat and as saturated fat as 36% and 11%, respectively, which are consistent with national United States data sets (Kris-Etherton and others 2012; Wright & Wang 2010). The proportion of total calories consumed as fat and saturated fat of the subject population were not dissimilar from those of the American population as a whole and were higher than national dietary recommendations.

Among the 150 participants, one participant missed the FF session, three missed the RF session, and two missed the RFS session. The full fat meal without additional spices was well liked overall with a mean liking score of 6.94. Reducing fat in the overall meal caused a significant drop in overall liking (6.35 RF vs. 6.94 FF, $p < 0.0001$, see Figure 2a), while adding herbs and spices attenuated the decline in meal liking scores such that the RFS condition was not significantly different from the FF condition (6.71 RFS vs. 6.94 FF, $p = 0.0803$). Similar findings were obtained for the chicken entrée and vegetable side dish when examined separately (see Figure 2b and 2c). Mean Likert scores for the overall meal and individual test meal items are shown in Table 6. Liking scores for both FF and RFS chicken were significantly greater than for RF.

Addition of herbs and spices to the creamy pasta did not restore liking to the level obtained for the FF condition (6.42 RFS vs. 7.47 FF, $p < 0.0001$). Liking of the RF condition was significantly lower than liking of the FF condition (6.47 RF vs. 7.47 FF, $p < 0.0001$). Mean consumptions of the three meal conditions were 85-87% of the food provided and there were no significant differences by test meal condition (see Table 6), which suggests that all the meal conditions were generally liked.

The mean Likert scores of each meal item for each test condition as rated by participants who habitually consumed fried chicken and roasted chicken are presented in Table 7. There were 99 (66.4%) participants who reported consuming fried chicken less than once monthly and 50 (33.6%) who consumed it one or more times per month. There were 55 (36.9%) participants who reported consuming roasted chicken less than once monthly and 94 (63.1%) who consumed it one or more times per month. Participants who ate roasted

chicken one or more times per month rated FF pasta lower than those who ate roasted chicken less than once monthly (7.26 habitual roasted chicken consumption vs. 7.84 infrequent roasted chicken consumption, $p = 0.0031$). This difference in liking persisted after adjusting for the frequency of fried chicken consumption (data not shown). Higher frequency of roast chicken consumption was inversely correlated with liking of both the FF chicken entrée ($r = -0.23$, $p = 0.004$) and the FF pasta dish ($r = -0.23$, $p = 0.005$).

In this study, the liking of reduced fat foods prepared with additional herbs and spices was comparable to the liking of the full fat overall meal, which is consistent with our hypothesis. This was also true for the French toast entrée, the chicken entrée, and the vegetable side dish. All three sausage conditions were liked equally well. The full fat pasta side dish was liked more than both the reduced fat version and the reduced fat with added spices version. Habitual consumption of sausage was not associated with liking of the breakfast meal, French toast entrée or sausage side dish. Habitual consumption of roasted chicken was associated with a decreased liking of full-fat chicken and pasta.

Research regarding liking of breakfast foods is currently limited to ready-to-eat cereals (Yeu and others 2008), with no literature focusing on other common breakfast foods, such as baked and fried bread products (e.g. muffins, pancakes, French toast). In their study, Yeu et al. examined the influence of added cinnamon flavor on consumer acceptance of a soy-based high-protein cereal (Yeu and others 2008). Addition of cinnamon flavor (21.6 g cinnamon powder/452.6 g extrudates) significantly increased both the aroma and flavor acceptance scores for the soy-based cereal ($p<0.05$). Yeu and others suggested that cinnamon flavor increased acceptance scores because the cinnamon added flavor to an otherwise bland product (Yeu and others 2008). Our finding that the addition of cinnamon, along with nutmeg and vanilla, attenuated the decline in French toast liking scores due to reduced fat content is likely the result of a similar effect. Namely, the addition of cinnamon offset the decrease in taste preference due to a reduction in overall fat content. The results of our study demonstrate that spices can be used to improve the liking of reduced fat French toast; however, additional research is warranted to determine if similar results would be seen with other common breakfast foods, such as muffins, pancakes and other bread products.

The effects of fat content on the liking of sausage products, along with methods for improving consumer liking of reduced fat sausage products have been studied extensively. The majority of studies have focused on using fat-replacers such as inulin, konjac gel and corn flour to help maintain a flavor and texture similar to full-fat sausage (Choi and others 2012; Osburn & Keeton 2004; Serdaroglu & Degirmencioglu 2004; Tomaschunas and others 2013b). These studies consistently found that fat replacers increased consumer acceptance of reduced fat sausage products (Choi and others 2012; Osburn & Keeton 2004; Serdaroglu & Degirmencioglu 2004; Tomaschunas and others 2013b). These findings differ from our study in which the participants liked all three sausage versions equally well, regardless of fat content or the addition of herbs and spices. This was an unexpected result, as we anticipated that participants would like the reduced fat sausage patties less than either the full fat or reduced fat plus spice sausage patties since fat is known to affect both the flavor and the texture of food, and texture affects overall liking of a food (Keeton 1994; Weiss and others 2010). Our results may have differed from those of other studies because

of the high fat content of the sausages in our study compared to previous studies. The fat content of the sausages in our study ranged from 54% to 69%, while the fat content of sausages in previous studies ranged from 3% to 20% (Choi and others 2012; Osburn & Keeton 2004; Serdaroglu & Degirmencioglu 2004; Tomaschunas and others 2013b). Our study used breakfast sausage patties, while previous studies examined hard encased sausages, which typically contain less fat and more protein. Additional research should be conducted to determine the point at which reducing the fat content of traditionally high fat foods decreases liking of those foods. This would be the fat level below which a benefit from additions (such as herbs and spices) would be seen.

The perceptions of meat and poultry products have been shown to influence their liking. Blind taste tests of conventional chicken, organic fast-growing chicken, and organic slow-growing chicken showed no taste preference of chicken breasts, however consumers rated organic chicken better than conventional in unblinded testing (Napolitano and others 2013). Consumers may have perceived organic chicken as healthier or better and therefore rated it more highly when this information was known to them. This is similar to findings that consumers reported liking sausages more and were more likely to purchase sausages when they were informed that the sausages were reduced fat (Helgesen and others 1998; Solheim 1992). The increased liking of sausages and likelihood of purchasing sausages held true even when consumers were given false information regarding the fat content of the sausages (Solheim 1992).

While there are multiple studies examining factors affecting the liking and consumption of sausage products as described above, influences on poultry consumption are less well-known. Brown and colleagues examined meat quality and sensory characteristics of chicken reared in four different production systems. Ratings for texture, juiciness, flavor, and overall preference were generally higher for the standard rearing system, which also produced chicken with the highest intramuscular fat levels (Brown and others 2008). We found that the addition of herbs and spices to reduced fat chicken did improve the liking of chicken over the reduced fat version without added herbs and spices.

We obtained self-reported frequency of consumption of fried chicken and roasted chicken over the previous year. We found no relationship between habitual fried chicken consumption and preference for the FF versus RF versions of each meal item. However, individuals who habitually consumed roasted chicken, a lower-fat method of cooking chicken, rated FF versions of the chicken entrée and pasta side dish significantly lower than those who did not habitually consume roasted chicken. Participants typically gave RFS versions of each item a rating in between that of the FF and RF versions, regardless of habitual fried chicken or roasted chicken consumption status (neither of which affected liking of the RFS items). Martínez-Ruiz and colleagues have found that, among individuals who received the same oral emulsion of the fatty acid linoleic acid, those who perceived the emulsion as containing a higher fat content had a lower preference for high-fat foods. Individuals with a lower preference for high-fat foods also consumed a smaller amount of high-fat foods, had a lower BMI, and a lower waist circumference compared to those who perceived the emulsion as containing medium or low levels of fat (Martinez-Ruiz and others

2014). Therefore regular consumption of lower fat foods appears to be inversely associated with preference for high fat foods, as was found in our study.

Our pasta was prepared in a cream (dairy) sauce. FF pasta received the highest liking score. Habitual fried chicken consumption did not significantly change FF pasta liking; however participants who habitually ate roasted chicken rated FF pasta lower than those who did not. Thus, individuals who habitually consumed lower fat poultry also preferred lower fat content in other meal items. The decreased liking of the RF and RFS pasta items may have resulted from changes in texture which affect their mouth feel. Previous research has shown that liking of a vanilla custard dessert decreased with reduced fat content, and the decreased liking of lower fat custard was primarily due to changes in texture (Tomaschunas and others 2013a). Identifying fat substitutes that account for changes in both flavor and texture of dairy-based products would be necessary in order to maintain consumer acceptability of reduced fat products.

Herbs and spices effectively attenuated decreased liking due to reduced fat content for French toast and chicken, but not for pasta. These differences could be due to the relative fat content of each of these items. The FF French toast and chicken items were 26% and 41% of calories from fat, respectively, while the FF pasta was 53% of calories from fat. It is possible that the particularly high fat content of the pasta reduced the potential for herbs and spices to improve liking of the reduced fat pasta and may be due to the effects of fat on the texture of foods (Keeton 1994; Weiss and others 2010). We previously demonstrated that herbs and spices effectively attenuated the decline in liking of reduced fat meatloaf (Peters and others 2014). The full-fat (49%) and reduced fat (33%) meatloaf entrees were similar in fat content to the chicken entrées in our current study (FF-41% and RF-30%), suggesting that herbs and spices are more likely to be effective when foods have a relatively lower fat content a priori. However, the decreased liking of the RF and RFS pasta could be due to the large reduction in total fat. The reduced fat had the highest levels of fat reduction (71%, compared with 44% for French toast, 40% for sausage, 40% for chicken and 63% for vegetables) compared with the other breakfast and lunch meal items. It is noteworthy that, in this study, we did not replace the fat that was removed with any added sugars or other carbohydrates which is often the case with commercial products labelled as reduced fat. In doing so, both fat and total calories were reduced in our study providing the greatest potential for reducing total energy intake. Additional research should examine the extent to which fat content can be reduced before liking of traditionally high fat foods decreases, how the relative fat content of foods affects the ability to attenuate reduced liking related to lower fat content, and how both flavor and texture affect said liking.

This study has several strengths. Our study participants had dietary fat intake similar to that of the general population whose diets are higher in fat than recommended by national guidelines. Meals were prepared with common ingredients available to home cooks for all meal items. All the meal conditions were generally liked. Most liking scores ranged from 6 to 7, where 6 corresponds to “like slightly” and 7 to “like moderately” on the nine-point hedonic scale. Participants did not do same day comparisons between meals, rather they had a wash-out period of at least 48 hours between tastings of test meal conditions. Therefore, the possibility of being unblinded to meal condition was reduced. Our participants chose

taste testing for the breakfast meal during either morning and midday hours, reducing the likelihood that non-habitual breakfast consumption affected participant rating of the breakfast meal or individual breakfast foods. We had a very low drop-out rate with 146 of the 151 (96.7%) breakfast participants enrolled and 150 of the 152 lunch participants enrolled (98.7%) completing the study for all three test meal conditions.

This study had some limitations. Test meal items were not fresh but were prepared ahead of time, frozen, and reheated the day of the study. Freshly prepared foods might have changed liking ratings. Participants were not informed about the differences in fat, herb, and spice content of the test meal items, however some spices were visible in RFS test items. Likewise, the FF chicken had the skin while RF and RFS chicken test conditions did not. Participants may have remembered the differences in visual appearance of the chicken and understood that chicken with the skin contains more fat than skinless chicken breasts, which may have affected their liking scores. Finally, we did not have similar representation of sexes, races, and ethnicities to that of the general American population.

Conclusions

In our study, the FF and RFS breakfast and lunch test meals received similar overall meal liking ratings and the amounts of food consumed were similar in all test meal conditions. The addition of herbs and spices to reduced fat items could be an effective strategy for helping Americans meet the US dietary guidelines for fat and saturated fat without sacrificing hedonic liking. Reducing total fat intake is a priority for many people seeking to reduce or maintain a lower body weight. Herbs and spices improve liking of lower fat versions of foods, such as French toast, chicken and vegetables.

Further studies are needed of foods with different macronutrient composition, with particular emphasis on higher fat food items such as dairy products, and to determine if herbs and spices can be utilized to attenuate decreased liking associated with reducing fat content in a wide variety of foods. Longer-term studies examining the sustainability of using herbs and spices to promote healthier eating are also warranted.

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Abbreviations

FF	full fat
RF	reduced fat with no added spice
RFS	reduced fat plus spice

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Practical Application

Americans consume more fat than is recommended in the *Dietary Guidelines for Americans.* This study shows that you can take foods like French toast, chicken or a vegetable side and cut the fat and calories by up to 50% while restoring flavor with herbs and spices. People typically use butter, cheese or fatty meat to enhance the flavor of their food.

We found that even when we reduced the fat in our meals by using lower-fat dairy and meat products but then added herbs and spices, we were able to deliver the flavor people desire for a fraction of the calories.

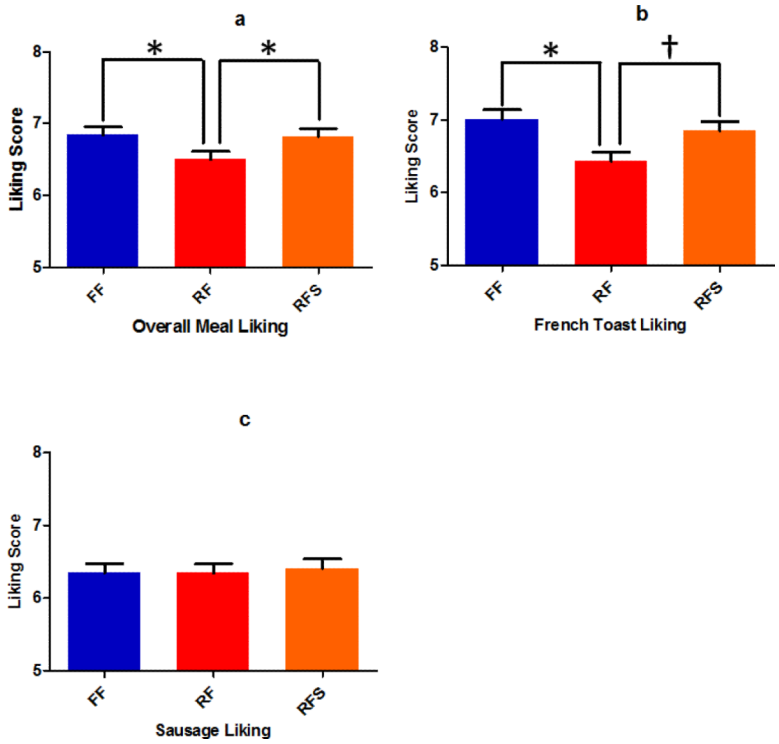

Figure 1. Liking Scores by Breakfast Test Meal Condition

Liking scores for ■ Full Fat (FF), ■ Reduced fat with no added spice (RF), and ■ Reduced fat plus spice (RFS) meal conditions are presented. * $P \leq 0.0030$, † $P < 0.0001$.

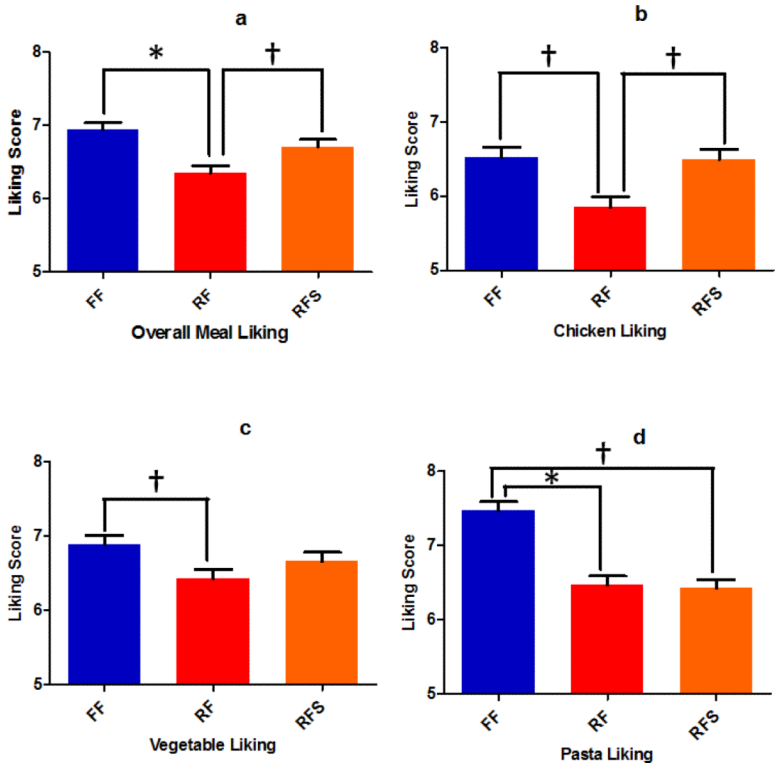

Figure 2. Liking Scores by Lunch Test Meal Condition

Liking scores for ■ Full Fat (FF), ■ Reduced fat with no added spice (RF), and ■ Reduced fat plus spice (RFS) meal conditions are presented. * $P < 0.0001$, † $P \leq 0.006$.

1

Total Dietary Fat, Saturated Fat, and Calories by Study and Test Meal Condition

Meal Item	Test Meal Condition								
	Full Fat			Reduced Fat[a]					
	Calories (kcals)	Fat(g)	Saturated Fat(g)	Calories		Fat		Saturated Fat	
				kcals	%Reduction	grams	%Reduction	grams	%Reduct
French Toast	280	8	4	250	11	4.5	44	2	50
Sausage	130	10	4	100	23	6	40	2	50
Total Breakfast Meal	410	18	8	350	15	10.5	42	4	50
Chicken	220	10	2.5	180	18	6	40	1.5	40
Vegetables	70	4	2.5	45	36	1.5	63	1	40
Pasta	240	14	9	160	33	4	71	2	78
Total Lunch Meal	530	28	14	385	27	11.5	59	4.5	68

[a]Reduced fat (and calorie) with no added spice and reduced fat (and calorie) plus spice

2

Breakfast Participant Characteristics and Habitual Dietary Intake[a] (N = 151)[b]

Characteristic	Response
Sex, n (%)	
Women	104 (69)
Men	47 (31)
Mean age, years (range)	36.5 (23.2 – 65.4)
Race[c], n (%)	
Caucasian	128 (86)
African American	8 (5)
Asian	11 (7)
Pacific Islander/Hawaiian	1 (1)
Native American	1 (1)
Ethnicity[c], n (%)	
Non-Hispanic/Latino	102 (81)
Hispanic/Latino	9 (7)
Latin American	1 (1)
Other	14 (11)
BMI (kg/m^2)[d], mean (SD)	24.3 (4.4)
Total calories per day, mean (SD)	1,631 (697)
Total fat, mean (SD)	
Grams per day	65 (33)
Percentage of total calories per day	36 (6)
Total saturated, mean (SD)	
Grams per day	20 (10)
Percentage of total calories per day	11 (3)
Frequency of sausage consumption, n (%)	
Never	35 (23)
6 times yearly	54 (36)
Monthly	33 (22)
28 times yearly	21 (14)
Weekly	4 (3)
13 times monthly	4 (3)

Abbreviations: BMI, Body Mass index; SD, Standard Deviation

[a] Data from the 2005 Block Food Frequency Questionnaire (FFQ)

[b] Percentages may not equal 100% because of rounding

[c] Data missing for 2 participants for race and 25 participants for ethnicity

[d] Calculated in the FFQ from self-reported height and weight

3

Mean Likert Scores for Breakfast Test Meal Items and Percentage of Meal Eaten by Test Meal Condition

Test Meal Item	Mean Score		
	Full Fat	Reduced Fat	Reduced Fat with Spice
Overall meal	6.84[a]	6.50[b]	6.82
French Toast	7.01[c]	6.43[d]	6.85
Sausage side dish	6.34	6.34	6.41
Mean percentage of meal eaten	83.7	84.1	83.8

[a] $p = 0.0016$ for difference from reduced fat

[b] $p = 0.0030$ for difference from reduced fat with spice

[c] $p < 0.0001$ for difference from reduced fat

[d] $p = 0.0031$ for difference from reduced fat with spice

4

Mean Likert Scores for Breakfast Test Meal Items by Test Meal Condition and Habitual Consumption of Sausage

	Test Meal Item	Mean Score		
		Full Fat	Reduced Fat	Reduced Fat with Spice
Frequency of Sausage Consumption[a]	Overall meal			
	<1/month	6.89	6.57	6.82
	≥1/month	6.76	6.40	6.88
	French toast entrée			
	<1/month	7.05	6.51	6.91
	≥1/month	6.93	6.33	6.81
	Sausage side dish			
	<1/month	6.28	6.33	6.48
	≥1/month	6.45	6.35	6.34

[a] N=87 who consumed sausage <1/month; N=58 who consumed sausage ≥1/month

5

Lunch Participant Characteristics and Habitual Dietary Intake[a] (N = 152)[b]

Characteristic	Response
Sex, n (%)	
Women	106 (7)
Men	46 (30)
Mean age, years (range)	36.6 (23.2 – 64.1)
Race, n (%)	
Caucasian	133 (88)
African American	7 (5)
Asian	11 (7)
Pacific Islander/Hawaiian	1 (1)
Ethnicity[c], n (%)	
Non-Hispanic/Latino	106 (81)
Hispanic/Latino	9 (7)
Latin American	1 (1)
Other	15 (12)
BMI (kg/m^2)[d], mean (SD)	24.3 (4.4)
Total calories per day, mean (SD)	1,614 (683)
Total fat, mean (SD)	
Grams per day	64 (32)
Percentage of total calories per day	36 (6)
Total saturated, mean (SD)	
Grams per day	20 (10)
Percentage of total calories per day	11 (3)
Frequency of fried chicken consumption, n (%)	
Never	19 (13)
6 times yearly	83 (55)
Monthly	23 (15)
28 times yearly	21 (14)
Weekly	5 (3)
13 times monthly	1 (1)
Frequency of roast chicken consumption, n (%)	
Never	4 (3)
6 times yearly	52 (34)
Monthly	27 (18)
28 times yearly	28 (18)

Characteristic	Response
Weekly	22 (15)
Biweekly	12 (8)
13 times monthly	6 (4)
Daily	1 (1)

Abbreviations: BMI, Body Mass index; SD, Standard Deviation

[a] Data from the 2005 Block Food Frequency Questionnaire (FFQ)

[b] Percentages may not equal 100% because of rounding

[c] Data missing for 19 participants

[d] Calculated in the FFQ from self-reported height and weight

6

Mean Likert Scores for Lunch Test Meal Items and Percentage of Meal Eaten by Test Meal Condition

Test Meal Item	Mean Score		
	Full Fat	Reduced Fat	Reduced Fat with Spice
Overall meal	6.94[a]	6.35[b]	6.71
Chicken	6.52[c]	5.85[d]	6.49
Vegetable side dish	6.89[e]	6.43	6.66
Pasta side dish	7.47[a]	6.47	6.42[f]
Mean percentage of meal eaten	87.5	85.1	85.5

[a] $p < 0.0001$ for difference from reduced fat

[b] $p = 0.0061$ for difference from reduced fat with spice

[c] $p = 0.0003$ for difference from reduced fat

[d] $p = 0.0005$ for difference from reduced fat with spice

[e] $p = 0.0006$ for difference from reduced fat

[f] $p < 0.0001$ for difference from full fat

7

Mean Likert Scores for Lunch Test Meal Items by Test Meal Condition and Habitual Consumption of Fried Chicken or Roasted Chicken

	Test Meal Item	Mean Score		
		Full Fat	Reduced Fat	Reduced Fat with Spice
Frequency of Fried Chicken Consumption[a]	Overall meal			
	<1/month	6.85	6.45	6.68
	≥1/month	7.10	6.14	6.76
	Chicken entrée			
	<1/month	6.42	5.90	6.52
	≥1/month	6.68	5.78	6.44
	Vegetable side dish			
	<1/month	6.76	6.47	6.55
	≥1/month	7.12	6.34	6.84
	Pasta side dish			
	<1/month	7.40	6.61	6.40
	≥1/month	7.60	6.20	6.46
Frequency of Roasted Chicken Consumption[b]	Overall meal			
	<1/month	7.07	6.35	6.59
	≥1/month	6.85	6.34	6.78
	Chicken entrée			
	<1/month	6.76	6.09	6.39
	≥1/month	6.36	5.72	6.55
	Vegetable side dish			
	<1/month	7.02	6.35	6.48
	≥1/month	6.80	6.47	6.74
	Pasta side dish			
	<1/month	7.84	6.39	6.44
	≥1/month	7.26[c]	6.52	6.40

[a] N=99 who consumed fried chicken <1/month, N=50 who consumed fried chicken ≥1/month

[b] N=55 who consumed roasted chicken <1/month, N=94 who consumed roasted chicken ≥1/month

[c] p = 0.0031 for difference from ≥1/month