STUDY OF THE EFFECT OF THREE PROTEIN SOURCES TO PROVIDE SATIETY IN HUMANS

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Summary

The satiety effect of three protein preload sources, beef, chicken and fish, was measured after 20 or 40 minute time delays subsequent to ingestion of a strawberry yogurt milkshake test meal in male and female subjects. Subjects were allowed 15 minutes to consume 100% of the protein preload source (120 g female, 200 g male) and at the specified time were given the milkshake test meal to drink until satiety (satisfaction or a feeling of fullness) was attained. Quantitative consumption of the milkshake was used to determine the satiety value of the protein source. This study involved a total of 41 subjects (26 female and 15 male). The design was analyzed using a mixed analysis of variance with two between-subject factors, gender and water, and two within-subjects factors (repeated measures), delay following preload and protein source. Each factor had two levels, except the protein source which had three: beef, chicken and fish. This study was patterned after that of Kissileff et al. (1984). The main effect of protein source showed that beef satiates longer than chicken or fish across all genders and time delays, $p < 0.0005$. Male subjects consumed greater amounts of yogurt shakes than females, $p < 0.01$. Less test meal consumed at 40 min time delay than at 20 min time delay, $p < .001$.

Introduction

Different types of foods satisfy hunger to different extents (Kissileff 1984, Rolls et al. 1988). The reasons for these satiating differences are not clear. Among the factors that have been suggested to have a causal role are rate of consumption of a food, energy and nutrient content of a food, the energy density or volume of the food, the sensory properties of the food, and beliefs about the satiety effect of a food (Kissileff 1984). The primary aim of the present study was to compare sources of protein for satiating efficiency.

Materials and Methods

Meats were procured in a frozen state. They were boneless, skinless chicken breast, beef eye of round (semitendinosus) and cod fillet. Meats were thawed overnight in 2-5°C refrigerator. Prior to broiling, meats were trimmed of all visible fat. Methods described in Guidelines for Cookery and Sensory Evaluation of Meat (1978) were followed for uniform scientific methodology: (a) open broiler pans were utilized so that moisture dripped into a lower pan, (b) pans were placed 12.7 cm from electric heating element in an electric oven, (c) meat was turned at 10 minutes and cooked on the opposite side until 70°C internal temperature was recorded on the meat thermometer. Meats were weighed on a balance, labeled and served to subjects. Females were served 120 g and males 200 g of protein preload. Laboratory analysis of the protein preload was Beef: 44.61% Crude Protein, 26.38% Moisture, 23.38% Fat; Chicken: 41.63% Crude Protein, 28.71% Moisture, 22.12% Fat; and, Fish: 49.69% Crude Protein, 25.82% Moisture, 20.09% Fat.

The test meal was a strawberry yogurt milkshake served at 13°C. Ingredients were blended for 1 min. They were: 112 g Dannon's Strawberry Yogurt, 32 g half and half, and 375 g 8% sucrose solution. Subjects were served 700 g in clear glasses and could receive additional test meal upon request. Both preload and test meal were weighed on an electronic balance before and after eating behavior testing. Satiating effect of the preload was calculated based on amounts of ingestion of milkshake test meal. The smaller the quantity of milkshake ingested, the more satiating the preload meat source.

Before final acceptance into the study, all subjects were required to sample the test foods and rate pleasantness of the taste of each. All foods had to be rated 50 mm or above on a 100 mm visual analog scale. The three foods to be used as preloads (chicken, fish and beef) and the test meal (strawberry yogurt milkshake) had to be rated within 15 mm of each other to ensure that they were of similar acceptability to the subjects. To qualify as normal weight, non-dieting subjects, individuals scored less than 15 on the Eating Attitudes Test, (Garner and Garfinkel 1979) and were not depressed, as indicated by low scores (0 or 1) on the General Health Questionnaire (Goldberg and Hillier 1979).

Subjects came to the laboratory at their usual lunch time between 1130 and 1330 hrs on six different days. They were instructed not to eat anything between breakfast and the test session and to eat the same breakfast before each of the test sessions. The subjects were given food diaries to record both the time and content of the breakfast and dinner before each session, and these were checked before each test session. Subjects were also told that it was important to keep their daily activity level and food intake normal and to report any vigorous exercise or unusually large or small meals before each session so that the session could be rescheduled. Each subject ingested each of the protein sources two times during the study. The test meal consisted of a strawberry yogurt milkshake (Kissileff 1986), which provided a mechanism to test the satiety effect of protein sources on subsequent food intake in normal weight, non-dieting males and female subjects. Eating time and initial palatability ratings were held constant.

Results and Discussion

The main effects of protein across all genders and times showed significance at ($F_{2,72} = 14.46$ figure, $p < 0.0005$) (Figure 1, Table 1). What seems to emerge is that beef is more satiating. Many weight reduction regimes have allowed only small amounts of beef in dietary patterns. Some exclude beef entirely from low calorie diets. These data indicate that beef suppresses hunger and subsequent ingestion of food and could, therefore, be included in low calorie weight reduction programs. The beef used in the study contained 153 Kcal/100 g, fat 6.2 g, protein 31.7 g, carbohydrate (CHO), 0.0 g. Chicken breast roasted without skin, 142 Kcal/100 g, 31.0 g fat, 26.7 g protein, 0.0 g CHO. 100 g cod fillet, 128 Kcal/100 g, 6.19 g fat, 37.5 g protein, 0.0 CHO. Therefore, when comparing beef, chicken and fish of similar energy and nutrient composition, beef satiates longest.

The main effect of time delay after preload was significant ($F_{2,72} = 13.44$, $p < 0.001$) (Figure 2), indicating that subjects who delayed longer (40 min) before drinking the shake after ingestion of the preload ate and drank more than those following the shorter 20 min delay interval. This indicates that the optimum satiety effect from protein may be achieved somewhere between 20 and 40 min after the termination of preload consumption. The potential implication is that the beef protein preload may inhibit the desire to consume additional calories.

There were significant main effects attributable to gender ($F_{1,36} = 7.37$, $p < 0.01$). Examination of the means indicated that male subjects over all conditions (time delay, water, and protein source) ingested greater amounts of the yogurt shake than did females (M = 387.0 g and F = 332.3 g) ($F_{2,72} = 55.14$, $p < 0.0005$) (Figure 3, Table 3).

The analysis of gender effects revealed a statistically significant interaction between gender and protein source ($F_{2,72} = 5.46$, $p < 0.006$) indicating that the three protein sources differed in their satiating effectiveness depending on the gender of the respondent (Figure 4). A look at the mean test meal yogurt shake consumption following preload consumption for males and females separately showed that beef was most satiating for males followed by fish followed by chicken (313.3 g, 410.9 g, 435.3 g, respectively). For females, beef provided the greatest satiation but chicken ranked second followed by fish (276.8 g, 298.8 g, 332.3 g, respectively.

Conclusion

The aim of this study was to determine if different protein sources (beef, chicken and fish) of isocaloric and similar fat levels vary in their ability to satiate the human subject. Two levels of preloads, 120 g for females and 200 g for males were given at 20 and 40 minute time intervals. Beef was found to reduce test meal intake significantly more than other protein sources which were matched for energy density. Sensory-specific satiety did not explain satiating efficiency of the beef. Thus, on a calorie restricted diet, the inclusion of lean beef is shown to be more satiating than chicken or fish in both male and female subjects and, therefore, contributes to decreased caloric ingestion. Further studies are required to determine why these meats have different satiating effects and whether consumption can be beneficial in weight reduction programs.

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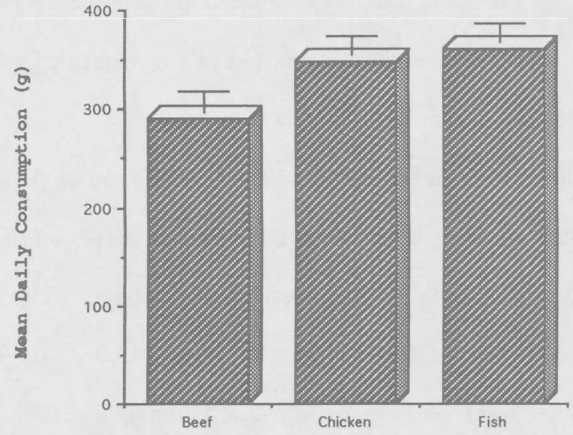

Figure 1. Total test meal consumption by Texas Tech University subjects across beef or chicken protein preloads. Data are mean and standard error of mean without regard for time delays, gender or water. $F_{2,72} = 14.46$, $p < 0.0005$.

Table 1. Total test meal consumption by Texas Tech University subjects across beef or chicken protein preloads regardless of time delay

Protein	Mean (g)	SEM
Beef	290.1	± 20.9
Chicken	348.3	± 20.1
Fish	361.1	± 19.0

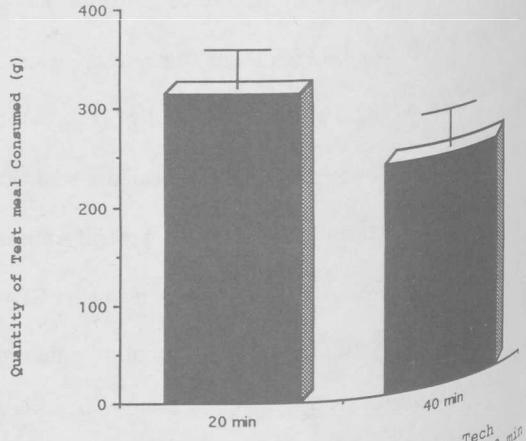

Figure 2. Consumption of test meal for Texas Tech University subjects at time delays of 20 min and 40 min across protein sources, gender, $F_{2,72} = 13.44$ $p < .001$

Table 2. Test meal consumption of two time delays at 20 min and 40 min across protein sources and gender

Time Delay	Mean (g)	SEM
20 min	314.3	±27.5
40 min	235.7	±28.5

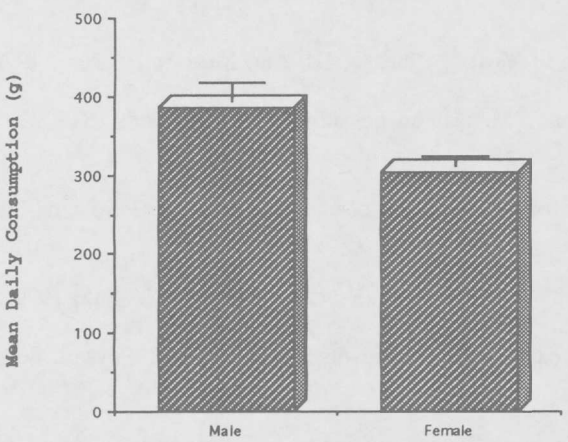

Figure 3. Total test meal consumption by Texas Tech University subjects across all protein preloads. Data are mean and standard error of mean without regard for time delays, protein source or water $F_{2,72} = 7.37$, $p < 0.01$.

Table 3. Total test meal consumption by Texas Tech University subjects across all protein preloads regardless of time delay

Gender	Beef (g)	Chicken (g)	Fish (g)	Mean (g)	SEM
Male	313.3	435.3	410.9	387.0	± 23.1
Female	276.8	298.8	298.8	332.3	± 12.2

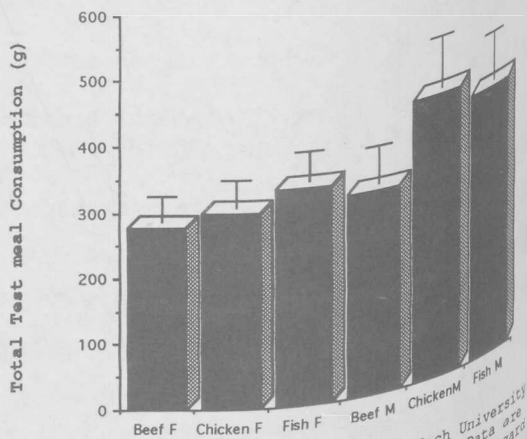

Figure 4. Test meal consumption by Texas Tech University subjects following protein preload. Data are mean and standard error of mean without regard for time delays, mean and SEM. Gender by protein interaction source $F_{2,72} = 5.46$, $p < 0.006$.

Table 4. Test meal consumption by Texas Tech University subjects following protein preload regardless of time delay

Protein	Mean (g)	SEM
Beef, Female	276.8	± 38.4
Chicken, Female	298.0	± 41.8
Fish, Female	332.3	± 46.1
Beef, Male	313.3	± 57.2
Chicken, Male	435.3	± 80.8
Fish, Male	410.9	± 75.0