

HUMAN NUTRITION

Title: The effects of protein quantity and source on postprandial satiety and plasma amino acid concentrations (#10-170) revised

This project is an addendum to our study co-sponsored by the National Pork Board (NPB Project #09-155) and the National Cattlemen's Beef Association to evaluate the effects of dietary protein quantity and predominant source on indices of appetite and whole body energy expenditure during weight loss.

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Institution: Department of Nutrition Science, Purdue University

Date Submitted: June 6, 2012

Industry Summary:

The objective of this study was to assess if the amount of protein an overweight or moderately obese adult consumes while reducing their energy intake to lose weight affects their appetite. The study also assessed if using lean beef and pork vs. soy and pulses as the main sources of protein made a difference in these appetite responses. For 3 consecutive 4-week periods of time, overweight/obese adults consumed diets that contained 750 Calories per day less than the amount of energy they needed for weight maintenance and contained 10%, 20%, or 30% energy from protein using lean beef and pork or soy and pulses as the main sources of protein. At the end of each 4-week period, they reported to a clinical laboratory, after an overnight fast, they consumed a test breakfast (breakfast sandwich containing English muffin, meat (lean beef and pork or meatless sausage patty) and cheese, fresh grapes and apple juice) that provided 25% of their prescribed daily energy and protein intakes. Blood samples were taken and appetite questionnaires were completed before consuming the meal and 15, 25, 60, 85, 120, 180, and 240 minutes post-meal. The results indicate that it is highly feasible for overweight/obese adults to successfully lose weight by consuming reduced energy diets that contain 10 to 30 percent of energy from protein, with lean beef and pork as the predominant sources of protein. These people experienced greater increases in plasma amino acids when they consumed greater amounts of protein in a meal, especially when the meal contained beef and pork vs. soy and pulses. Higher protein intake from both lean beef and pork or soy and pulses promoted decreased hunger and desire to eat and greater fullness responses after a meal. Ingesting a meal with 30% of

These research results were submitted in fulfillment of checkoff-funded research projects. This report is published directly as submitted by the project's principal investigator. This report has not been peer-reviewed.

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energy from protein was superior to when the meals contained 10 or 20% of energy from protein. In conclusion, consuming higher amounts of protein from lean beef and pork foods helps overweight and moderately obese adults curb their appetite (reduce their hunger) after eating. Funding, wholly or in part, was provided by The National Pork Board, The Beef Checkoff, and NIH RR025761. For more information contact Wayne W. Campbell, PhD, Dept. of Nutrition Science, Purdue University, 765-494-8236, campbellw@purdue.edu.

Keywords: Plasma Amino Acids, Satiety, Appetite, Hunger, Protein

Scientific Abstract: (This abstract was submitted to Experimental Biology, 4/12)

Effects of protein quantity and source (animal versus plant) on appetite and plasma amino acid responses in energy-restricted subjects

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This study was designed to assess appetitive and plasma amino acid (AA) responses to protein (P) intakes that span the acceptable macronutrient distribution range and predominantly from meat vs. plant sources. Thirty-four overweight/obese subjects (53 ± 12 y, BMI 30.8 ± 2.6 kg/m² mean \pm SD) were randomly assigned to consume diets with 750 kcal/d below energy need and beef/pork (5M:12F) or soy/pulses (6M:11F). All subjects randomly completed 3, 28d trials with the diets containing 10, 20 or 30% energy from P. On day 28 of each trial, subjects consumed a trial specific test meal and rated hunger and fullness before and 25, 60, 120, 180 and 240 min after eating. AAs were measured in 5 subjects each from the two P source groups. Postprandial (PP) branched chain, essential, and large neutral AA and leucine (weighted averages) were higher for beef/pork vs. soy/pulses ($p < 0.05$) and progressively higher with increasing P intake ($p < 0.01$). PP hunger was lower and fullness was higher than fasting ($p < 0.001$). The hunger response was greater for 30 vs. 20 and 10 % P, whereas P quantity did not affect fullness. Protein source did not affect hunger or fullness. PP hunger and fullness responses were not related to PP AA responses. Higher protein intake from meat or plant sources promotes reduced hunger, unrelated to differential plasma amino acid responses to feeding.

Grant Funding Source: The Beef Checkoff, National Pork Board, and NIH RR025761

Introduction from original proposal:

Protein is the most satiating macronutrient. Meals containing higher amounts of protein are more satiating than lower protein meals (1). Regarding plasma amino acid profiles, increased protein intake across the AMDR increased and sustained the rise in total and branch chain plasma amino acid concentrations 180 to 240 minutes after consumption of a breakfast with 25% vs. 10% energy from casein protein and coincided with an increase in satiety (2). Similar results were also observed following consumption of a breakfast containing 25 vs. 10% energy from soy protein (3). These observations are supported by Mellinkoff et al. "aminostatic" theory, which states that increased protein consumption results in increased plasma amino

acid concentrations (4). Differences in the tertiary structure of individual amino acids may affect their behavior in the gastrointestinal tract and therefore their effectiveness, or quality (5). This may help explain the relationship between differential responses of protein quantity/source and satiety. Recent studies report that both pork and soy protein sources increase postprandial thermogenesis, with pork 2% higher than soy (6). In this study, histidine, methionine + cysteine, and tryptophan were limiting factors for protein synthesis, with the pork diet containing 27% more histidine and 14% more methionine + cysteine than an equivalent soy diet, as well as ~5% more leucine (6) which is especially thermogenic (8) and stimulates muscle protein synthesis (9). Given the strong positive correlation between thermogenesis and satiety (7), a reported association between plasma amino acid concentration and satiety (2, 3), and the absence of studies investigating the effect of red meat consumption, an investigation of the effect of both protein quantity and source (red meat and soy) on postprandial plasma amino acid concentrations and satiety is warranted.

Stated Objectives from original proposal:

To assess the effects of dietary protein quantity across the acceptable macronutrient distribution range (AMDR, 10%, 20% and 30% of energy) and predominant source (30% of protein intake from red meat or soy) on postprandial appetite (i.e. satiety) and plasma amino acid profile after consumption of an energy-restricted meal in overweight adults.

Specific Aims:

Aim 1: Plasma Amino Acid Concentrations - Hypothesis: Increasing protein content (esp. red meat vs. soy) will result in progressively greater and sustained plasma amino acid concentrations. The differential responses will not be different between the beef/pork and soy/pulses groups of subjects.

Aim 2: Satiety - Hypothesis: Increasing plasma amino acid concentrations (esp. red meat vs. soy) will result in progressively more robust/sustained changes in satiety (decreased hunger/desire to eat and increased fullness). The differential responses will not be different between the beef/pork and soy/pulses groups of subjects.

Materials & Methods:

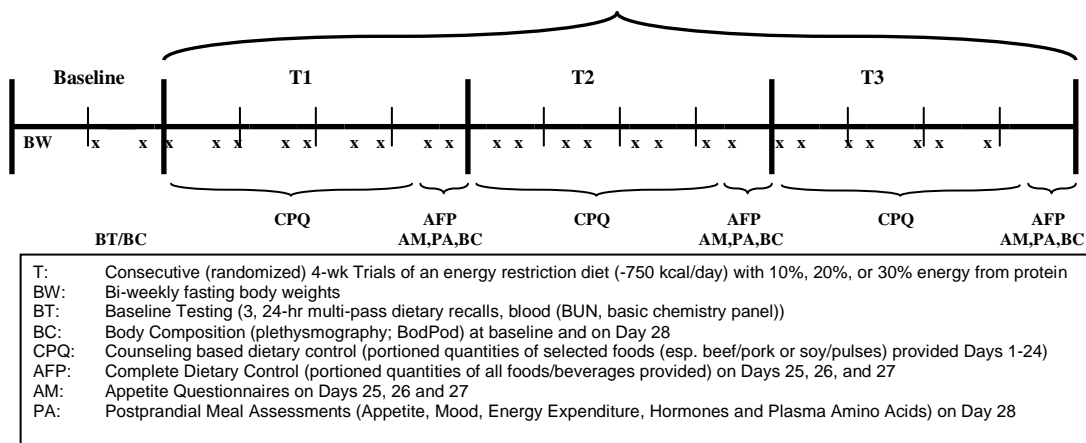
Subjects and Recruitment: Men and women (age 21y or older, body mass index 27-37 kg/m²; non-smoking; weight stable (\pm 3 kg) during previous 3 months; energy need for weight maintenance 2000-3150 kcal/day; usual protein intake within the AMDR; not dietary restrained; menstruating women not pregnant or lactating; constant habitual activity patterns within last 3 months; no acute illness; not diabetic or have chronic diseases known to influence protein or energy metabolism; blood profile within 10% of clinical normalcy; not hypertensive; no use of medications known to influence appetite or protein and energy metabolism; willingness to eat study foods; and able to travel to testing facility) were recruited from the greater Lafayette, IN, region using

advertisements in newspapers, community bulletin boards, and community newsletters. The study physician reviewed the information from these assessments and medically approved their participation. Subjects signed an informed consent document approved by the Purdue University Institutional Review Board and were monetarily reimbursed for their time and efforts.

Experimental Design (Parent NPB Project #09-155): Subjects were randomly assigned to either the lean beef/pork or soy/pulses group and consumed, in random order, 3 consecutive 4-week trials of an energy restriction diet (-750 kcal/day) that contained 10%, 20%, or 30% energy from protein with lean beef/pork or soy/pulses as the predominate sources of protein. The features of this cross-over design protocol are summarized in the figure below:

14-wk Parallel Group Experimental Design

Energy Restriction Diet (-750 kcal/day) with 10%, 20%, or 30% Energy from Protein
Predominate Protein Sources = Lean Beef/Pork or Soy/Pulses

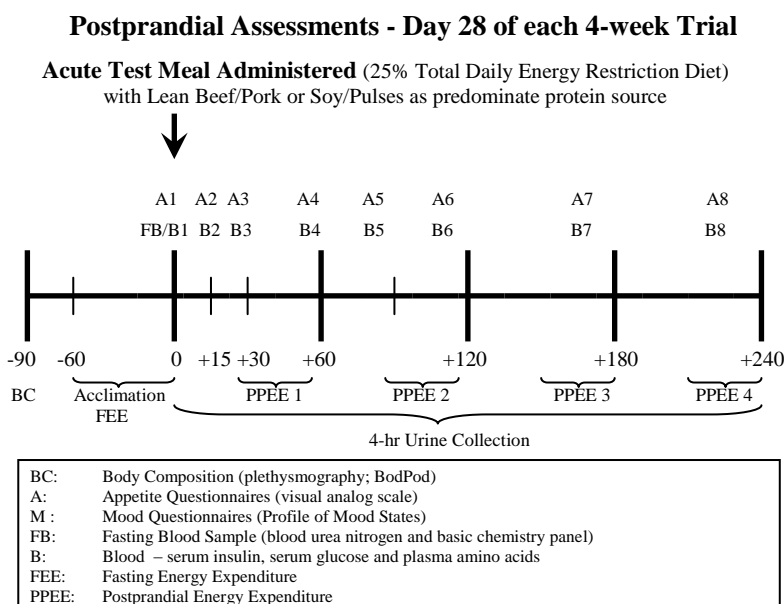


Each subject's energy requirements were estimated using the sex-specific equation published by the Institute of Medicine (10). Subjects consumed an energy restriction diet (-750 kcal/day) containing 25% fat, 10%, 20%, or 30% protein (with lean beef/pork or soy/pulses whole food products as the predominant protein sources) and 65%, 55%, or 45% carbohydrate. The sources of protein followed those typically consumed by adults (11), including ~30% lean beef/pork or soy/pulses, ~20% dairy, ~5% egg, ~20% grains/breads/flours, and ~25% other (i.e. vegetables, fruits, and nuts). A 7-day menu cycle was developed for each 4-week trial using Pronutra metabolic feeding study software (Viocare, Inc. Princeton, NJ). Subjects consumed one multivitamin (Centrum Silver; Wyeth Consumer Healthcare, Richmond, VA) and calcium/vitamin D supplement (Citracal; Bayer Healthcare, LLC, Morristown, NJ) daily to insure adequate micronutrient intake during the 12-week dietary intervention. Ad libitum water intake, salting and seasoning of food, and non-energy caffeine-containing beverages were allowed.

Dietary Compliance: Subjects were provided, on Days 1-24 of each 4-week trial, portioned quantities (each item weighed to $\pm 0.1g$) of selected foods (esp. beef/pork or soy/pulses) and were counseled to follow a prescribed menu of specific foods and beverages to achieve the desired macronutrient and energy intakes (See sample menus in Appendix 1). On Days 25-27 of each 4-week trial, subjects were provided all

foods and beverages for consumption outside the lab, and were instructed to consume all of the foods and beverages provided and to not consume any other items, except water (See sample menus in Appendix 2). Throughout the study, subjects were encouraged to only consume the prescribed and provided foods and beverages, and to report any non-compliance. Fasting serum urea nitrogen (BUN) measured on Day 28 of each 4-week trial was used as a crude index of dietary protein intakes during the study (12-14) and a measure of dietary compliance.

Experimental Design (NPB Project #10-170): Plasma samples from 5 subjects (5 females) and 5 subjects (1 male; 4 females) who completed the beef/pork and soy/pulses protocols, respectively, were used to measure plasma amino acid profile. The experimental design employed for this study results in the main effects of protein quantity being statistically evaluated using data from n=16 subjects (8 beef/pork and 8 soy/pulses subjects combined) and protein source with n=48 subjects (16 subjects total times 3 trials).



Prescribed Test Meal: At the end of each 4-week trial (Day 28), subjects reported to the clinical laboratory after an overnight fast for postprandial meal assessments (see Postprandial Assessments figure above). After voiding, subjects were weighed, urine collection began, blood pressure and appetite were measured, and fasting blood was drawn. After resting energy expenditure testing, subjects consumed a test meal providing 25% of their daily energy need and protein content/source of the diet they were consuming at the time of testing. The test meal (see Figure 1) consisted of portioned quantities of a breakfast sandwich containing English muffin, meat (lean beef and pork or meatless sausage patty) and cheese, and served with fruit and juice (15). Blood samples were taken and appetite questionnaires were completed 15, 25, 60, 85, 120, 180, and 240 minutes post-meal. Subjects were not allowed to read, watch TV, talk on a cell phone, or work on a computer during this time, or eat or drink anything except for what is provided to you at the beginning of the testing period. After completion of the 4-hour testing period, subjects were provided lunch and pack-out foods for dinner (See sample menus in Appendix 3).

Figure 1: Test meal (beef/pork on left and soy/pulses on right) consisted of portioned quantities of a breakfast sandwich containing English muffin, meat (lean beef/pork or soy breakfast patty) and cheese, and served with margarine, red grapes, apple white grape juice, and water.



Measurements (NPB Project #10-170):

Clinical Health Assessments: Fasting-state (-55 min) plasma amino acids were collected prior to postprandial testing (Day 28 of each 4-week trial) and 15, 25, 60, 85, 120, 180, and 240 minutes post-meal. Plasma free amino acids (PSer, Tau, PETN, urea, Asp, Hyp, Thr, Ser, Asn, Glu, Gln, Sar, Aad, Pro, Gly, Ala, Cit, Abu, Val, Met, Cys, Ile, Leu, Tyr, Hyc/AHyc, Phe, Bala, Gaba, HCys, Etn, Trp, Hyl, Orn, Lys, 1-MHis, His, 3-MHis, Ans, Carn, and Arg) for timepoints (-55, 25, 60, 120, 180 and 240 min) were quantified by cation-exchange chromatography (cIEC-HPLC) coupled with post-column ninhydrin derivatization and quantitation (16) by the Agricultural Experimental Station Chemical Laboratories University of Missouri-Columbus.

Appetite Assessment: Subjects rated their appetite (hunger, desire to eat, and fullness) using a 100-mm quasilogarithmic visual analog scale (i.e. general labeled magnitude scale), with descriptors ranging from “barely detectable” to “strongest sensation imaginable of any kind” (17). The questionnaire was completed during postprandial meal testing on Day 28 prior to and 15, 25, 60, 85, 120, 180, and 240 minutes post-meal.

Statistical Analyses: The main effects of dietary protein intake (10%, 20%, and 30%; within-subject effect) and protein source (beef/pork vs. soy/pulses; between-subject effect) and their interactions on plasma amino acids was determined using repeated measures ANOVA. Post hoc analyses were conducted using the LSD method when a significant omnibus F-test was established from the repeated measures ANOVA. Pearson Correlations were used to determine the relationship between postprandial plasma amino acid concentrations and appetite responses. All statistical analyses were performed using SPSS statistical software version 19.0.0 (IBM Corporation, Armonk, New York). Statistical significance will be assigned at $P < 0.05$. Data is reported as means \pm SD (except where noted).

Results:

Thirty-four individuals (11 males;34 females) completed this 14-wk protocol, 13 participants (28%) failed to complete the study for various reasons. There were no significant differences in baseline (Week 2) subject characteristics between groups (see Table 1).

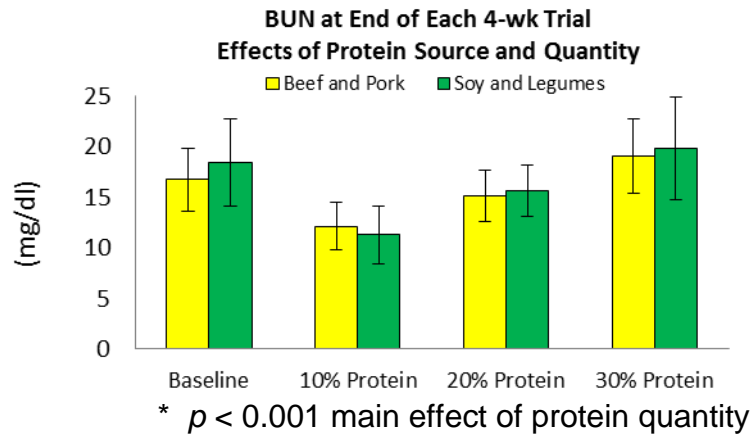
Table 1: Baseline Subject Characteristics

	Total (n=34)	Beef and Pork (n=17)	Soy and Legumes (n=17)
Sex	11 Males 23 Females	5 Males 12 Females	6 Males 11 Females
Age (y)	53.4 ± 12.4 Range (23-75)	51.2 ± 9.8 Range (30-66)	55.7 ± 14.5 Range (23-75)
Weight (kg)	87.5 ± 11.8 Range (69.9-111.8)	86.9 ± 11.8 Range (69.9-108.8)	88.1 ± 12.1 Range (70.3-111.8)
BMI (kg/m²)	30.8 ± 2.6 Range (26.2-37.8)	31.0 ± 2.7 Range (27.1-37.8)	30.7 ± 2.5 Range (26.2-36.8)
Energy Restriction Diet Prescription * (kcal/day)	1743.4 ± 331.6 (Range 1200-2400)	1746.5 ± 342.1 (Range 1200-2400)	1740.2 ± 331.2 (Range 1200-2400)
Fasting Serum Glucose (mg/dl)	87.6 ± 9.7 Range (50-107)	86.2 ± 11.4 Range (50-105)	89.1 ± 7.7 Range (77-107)
Fasting Serum Insulin (µU/dl)	10.7 ± 6.1 Range (3.5-30.6)	11.6 ± 6.7 Range (4.4-30.6)	9.7 ± 5.4 Range (3.5-21.9)
Fasting BUN (mg/dl)	17.6 ± 3.8 Range (12.5-26)	16.7 ± 3.1 Range (12.5-23.5)	18.4 ± 4.3 Range (12.5-26.0)

* -750 kcal/day from Energy Weight Maintenance Requirements

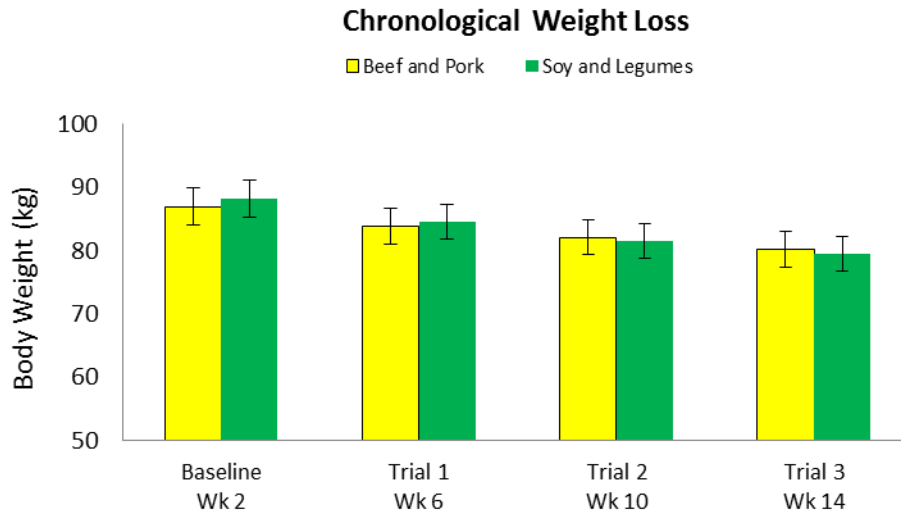
Consistent with expectations, fasting blood urea nitrogen concentration was progressively higher with increasing dietary protein intake (see Figure 2). The predominant source of protein did not influence this response.

Figure 2: Fasting BUN at baseline (week 2) and after chronic feeding of each protein quantity for 4 weeks.



Subjects in both protein source groups progressively lost weight during the 12 weeks of energy restriction (see Figure 3) (main effect of time ($p < 0.001$ for all time points and post hoc – all time points in each group different from each other ($p < 0.001$)). Group x time interaction $p = 0.007$ – Beef and Pork group sig different Baseline – Wk 14. Soy and Pulses sig different Baseline – Wk 10 and Baseline – Wk 14.)

Figure 3: Weight loss (fasting body weight) at baseline (week 2) and after chronic feeding of each protein quantity for 4



weeks.

* Mean \pm SEM

$p < 0.001$ main effect of time

Over time, fat mass and fat-free mass decreased, consistent with weight loss (see Table 2). The quantity and predominant sources of protein did not influence these responses.

Table 2: Changes in Body Composition During Each 4-wk Trial

	Group	10% Protein	20% Protein	30% Protein
Weight (kg)	Beef and Pork	-2.56 ± 1.51	-2.36 ± 1.27	-1.96 ± 1.25
	Soy and Legumes	-2.86 ± 1.64	-2.88 ± 1.20	-2.79 ± 1.35
Fat Mass (kg)	Beef and Pork	-2.19 ± 1.99	-1.66 ± 1.51	-2.09 ± 1.81
	Soy and Legumes	-2.03 ± 1.25	-2.13 ± 1.60	-2.62 ± 1.43
Lean Mass (kg)	Beef and Pork	-0.37 ± 1.38	-0.69 ± 1.44	0.13 ± 1.74
	Soy and Legumes	-0.83 ± 1.77	-0.75 ± 1.27	-0.17 ± 1.15
% Fat Mass	Beef and Pork	-1.44 ± 1.76	-0.98 ± 1.63	-1.61 ± 2.10
	Soy and Legumes	-1.30 ± 1.52	-1.33 ± 1.65	-1.87 ± 1.50
Fat Mass Index (FM(kg)/Ht(m²))	Beef and Pork	-0.81 ± 0.74	-0.60 ± 0.54	-0.74 ± 0.65
	Soy and Legumes	-0.72 ± 0.43	-0.75 ± 0.55	-0.90 ± 0.49
Lean Mass Index (LM(kg)/Ht(m²))	Beef and Pork	-0.11 ± 0.48	-0.23 ± 0.49	-0.02 ± 0.61
	Soy and Legumes	-0.27 ± 0.58	-0.25 ± 0.42	-0.07 ± 0.41

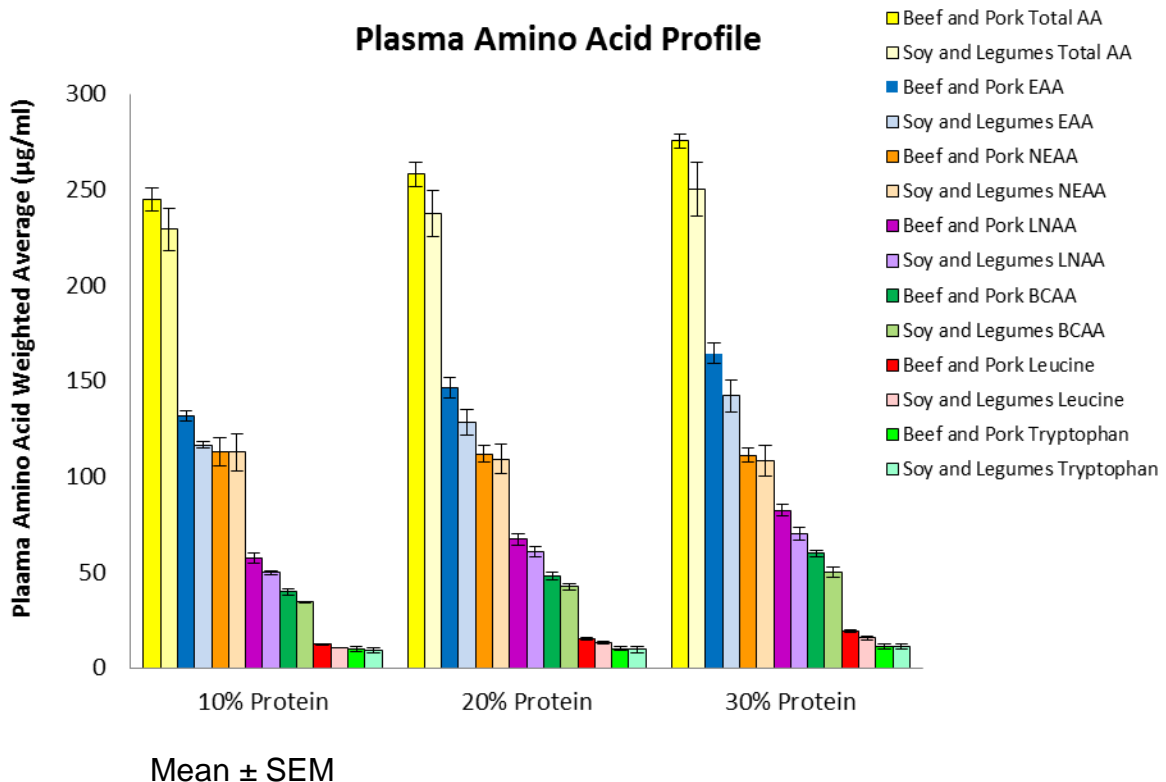
Effects of the Protein Quantity on Postprandial Plasma Amino Acid Concentrations, Appetite, and Mood

Ten individuals (1 male; 9 females), matched according to their test specific energy requirements, had their plasma amino acid profile quantified (see Figure 4). There were no significant differences in baseline subject characteristics between groups (see Table 3).

Table 3: Baseline Subject Characteristics of Amino Acid Subset

	Beef and Pork (n=5)	Soy and Legumes (n=5)
Sex	5 Females	1 Male 4 Females
Age (y)	53 ± 7 Range (41-57)	51 ± 18 Range (23-68)
Weight (kg)	85.6 ± 12.4 Range (71.1-100.0)	78.0 ± 7.4 Range (70.3-87.7)
Test Meal (kcal)	390.0 ± 65.2 (Range 300-450)	390.0 ± 65.2 (Range 300-450)

Figure 4: Plasma amino acid profiles (weighted averages)



Plasma Amino Acids:

Postprandial branched chain (Figure 6), essential (Figure 7) large neutral amino acids (Figure 8) and leucine (Figure 9) concentrations (weighted averages) were higher for beef/pork vs. soy/legumes ($p < 0.05$) and progressively higher with increasing protein intake ($p < 0.01$). Independent of source, total amino acids (Figure 5) and tryptophan (Figure 10) were higher at 30% vs. 20 and 10% protein ($p < 0.01$), and tryptophan:large neutral amino acids ratio (Figure 11) was lower at 30% vs. 10 and 20 vs. 10% protein ($p < 0.05$). No differences were observed for non-essential amino acid concentrations (Figure 12).

Figure 5: Total plasma amino acids by predominate protein source and quantity.

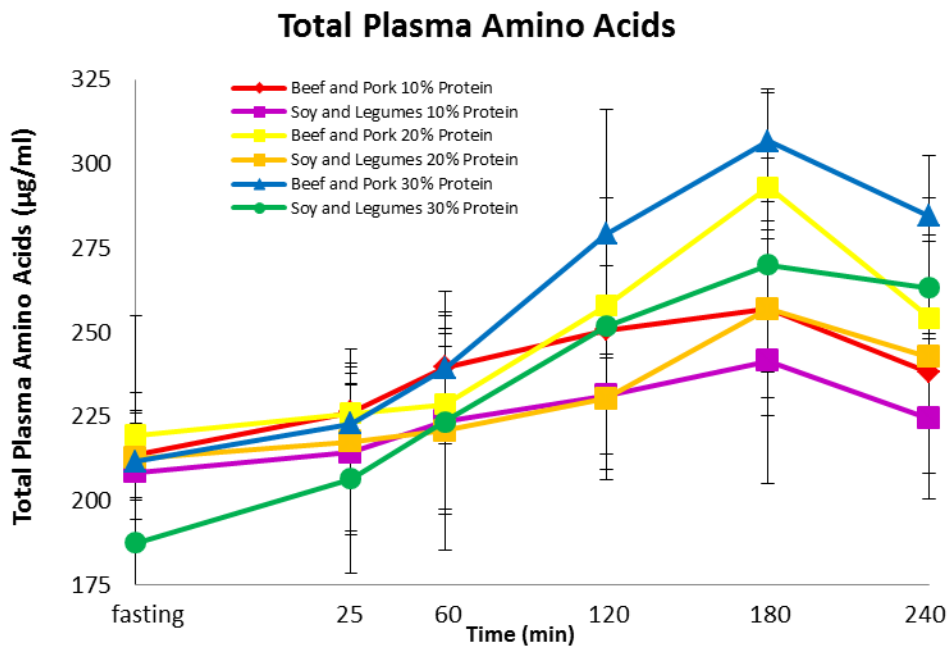


Figure 6: Branched chain amino acid by predominate protein source and quantity.

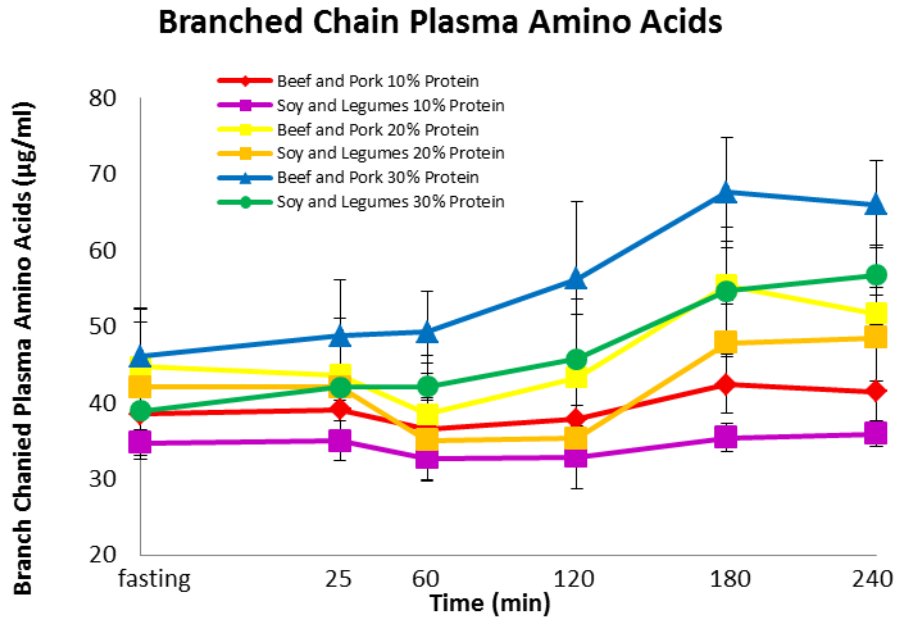


Figure 7: Essential amino acid by predominate protein source and quantity.

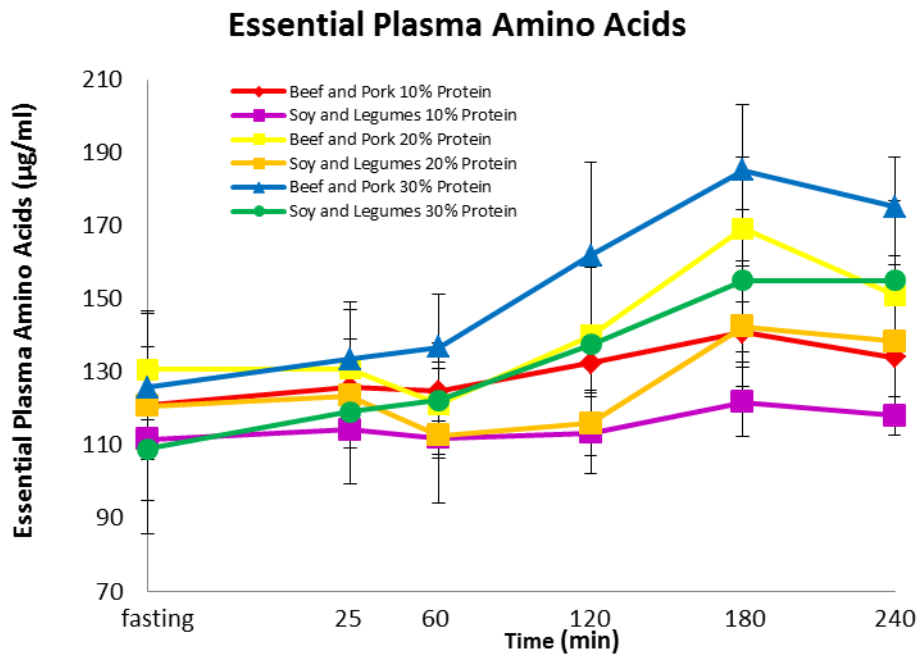


Figure 8: Large neutral amino acid by predominate protein source and quantity.

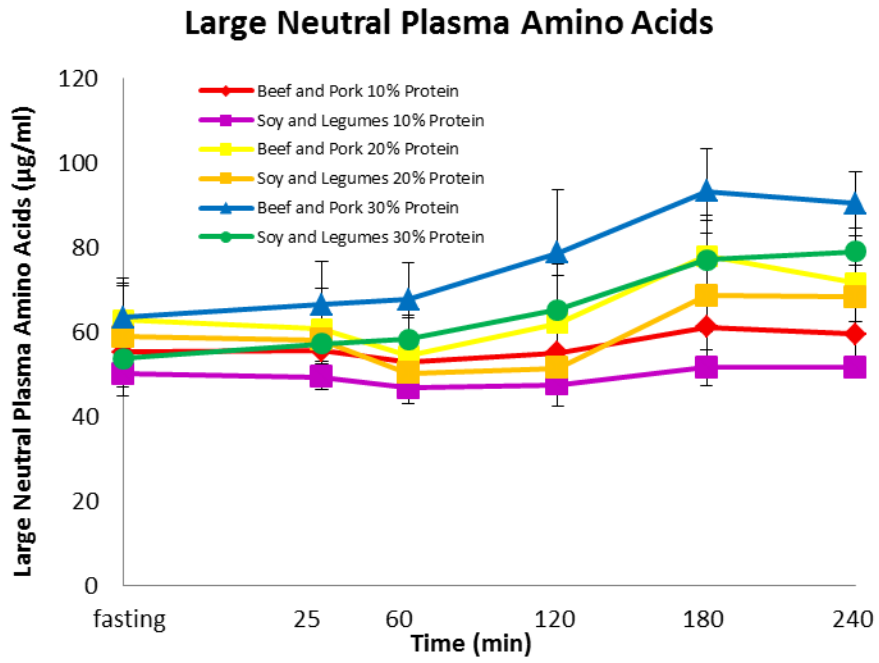


Figure 9: Leucine by predominate protein source and quantity.

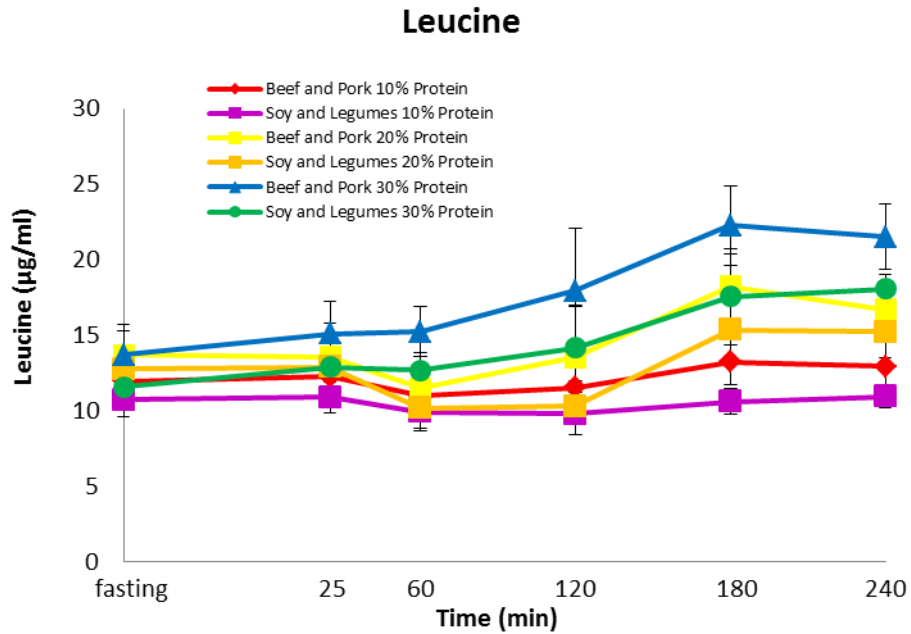


Figure 10: Tryptophan by predominate protein source and quantity.

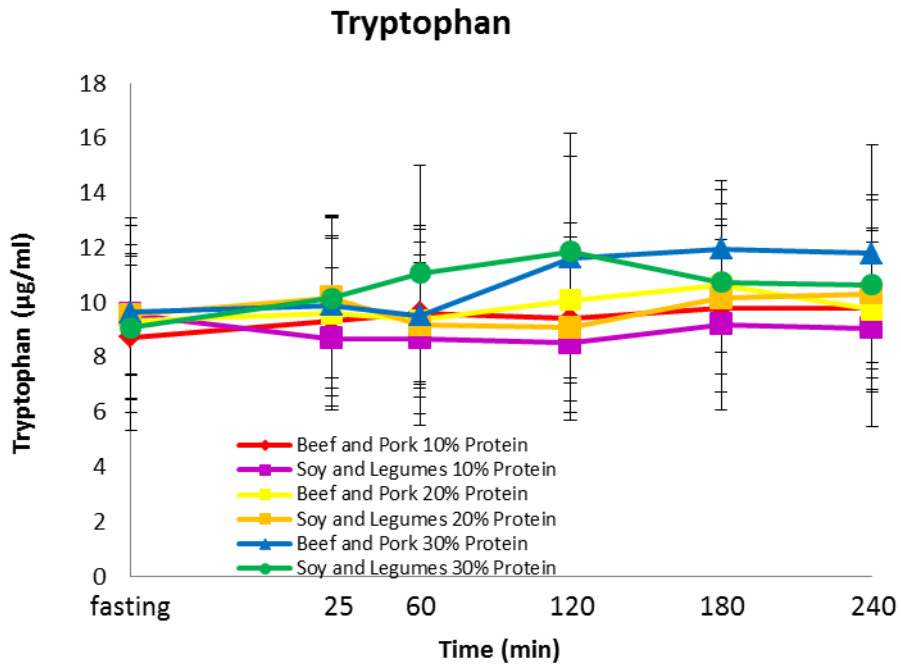


Figure 11: Tryptophan:large neutral amino acid ratio by predominate protein source and quantity.

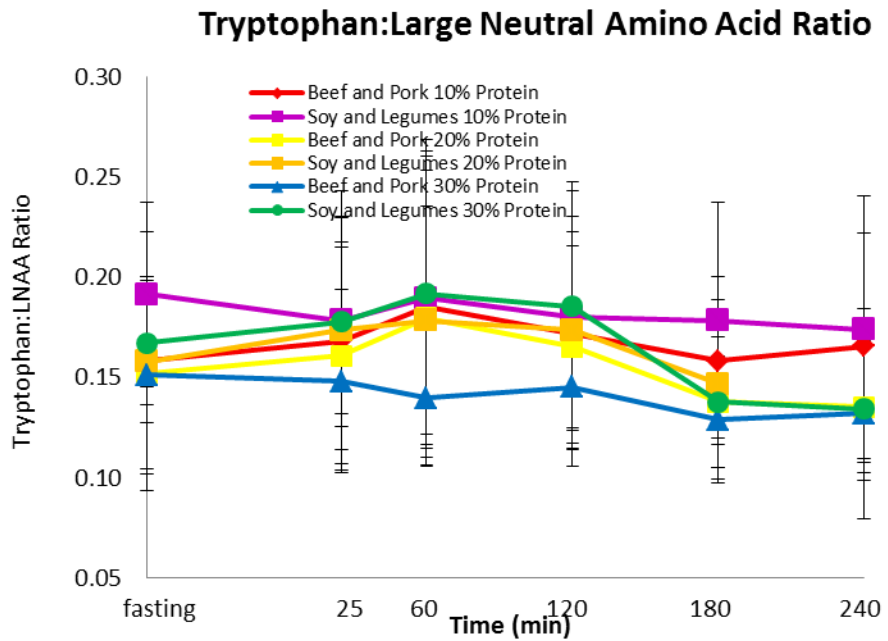
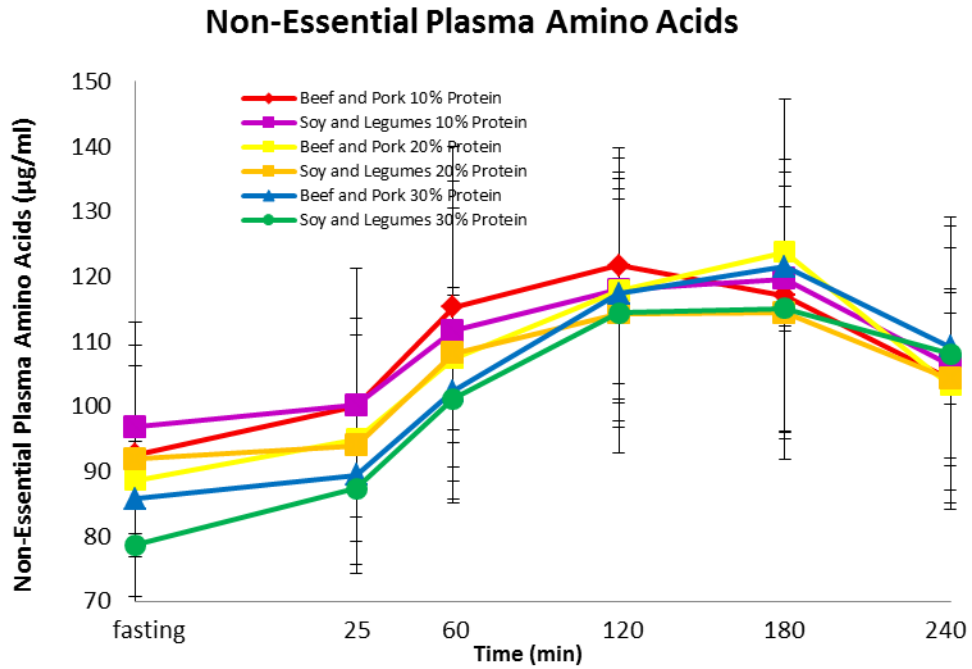


Figure 12: Non-essential amino acids by predominate protein source and quantity.



Appetite:

Postprandial appetite response (weighted averages) were not related postprandial total amino acid response (delta weighted average) (see Figure 13) Protein quantity and source did not affect postprandial appetite responses (weighted averages) (see Figures 14-16).

Figure 13: Correlation between appetite responses and total amino acids.

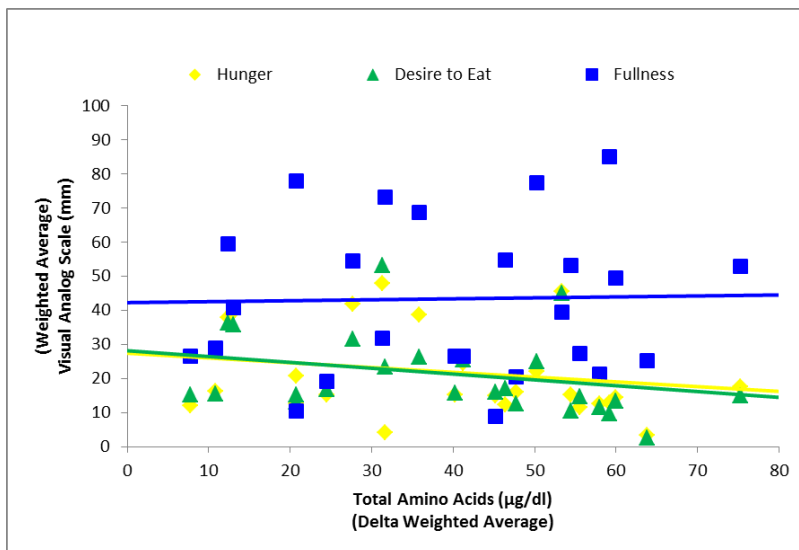
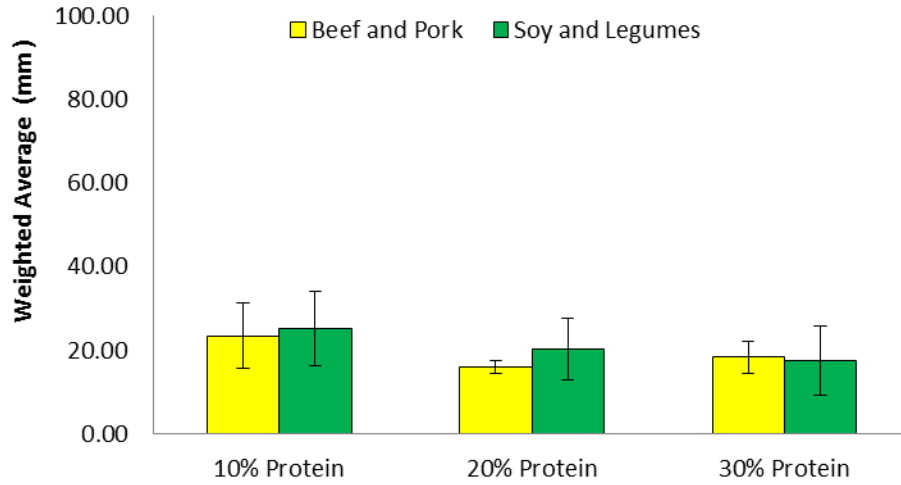


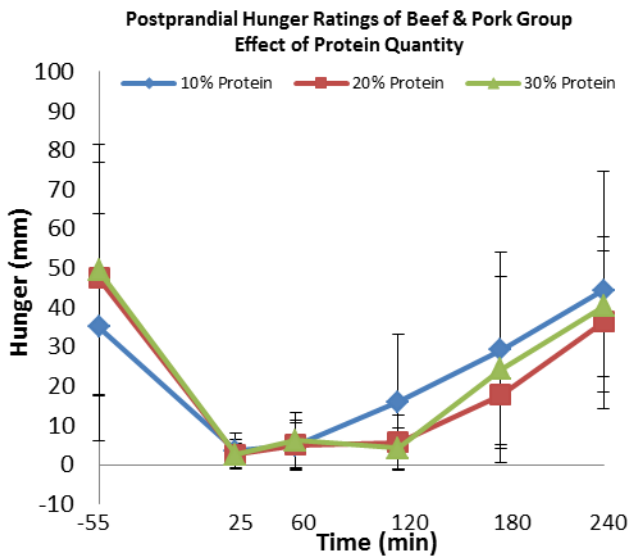
Figure 14: Postprandial hunger weighted average (A) and mean response (B and C) by predominate protein source and quantity.

A Perceived Postprandial Hunger Response



Mean \pm SEM

B



C

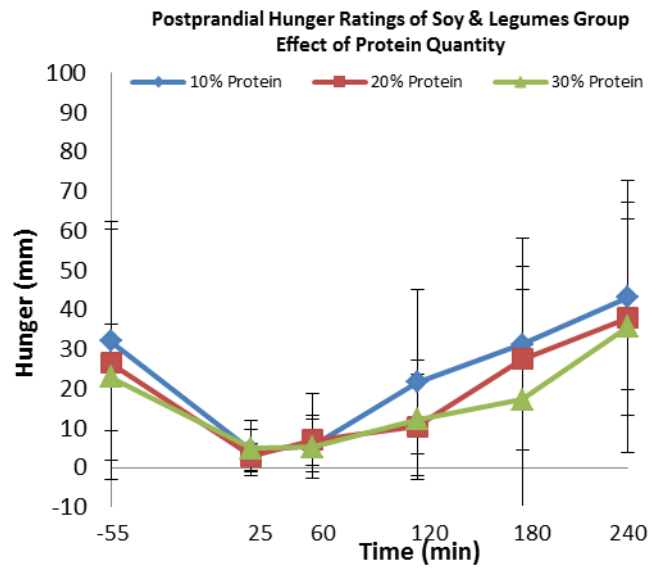


Figure 15: Postprandial desire to eat weighted average (A) and mean response (B and C) by predominate protein source and quantity.

A Perceived Postprandial Desire to Eat Response

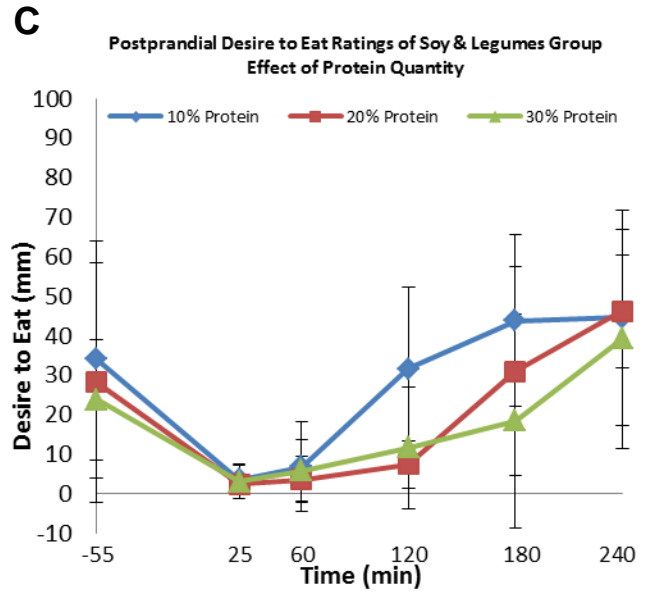
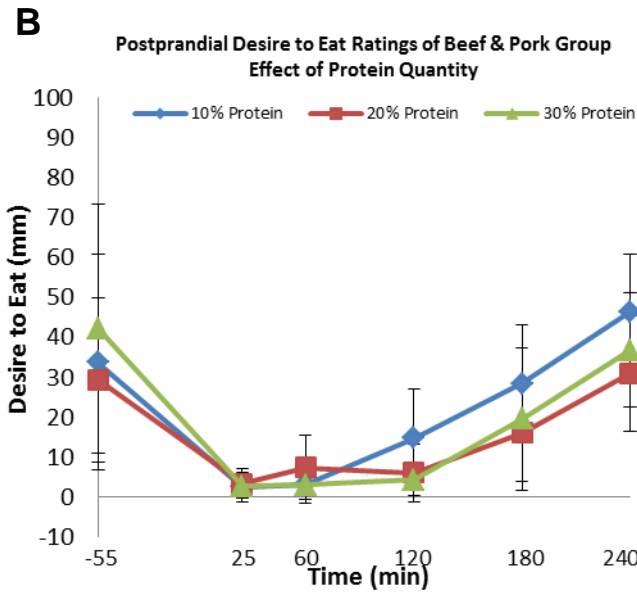
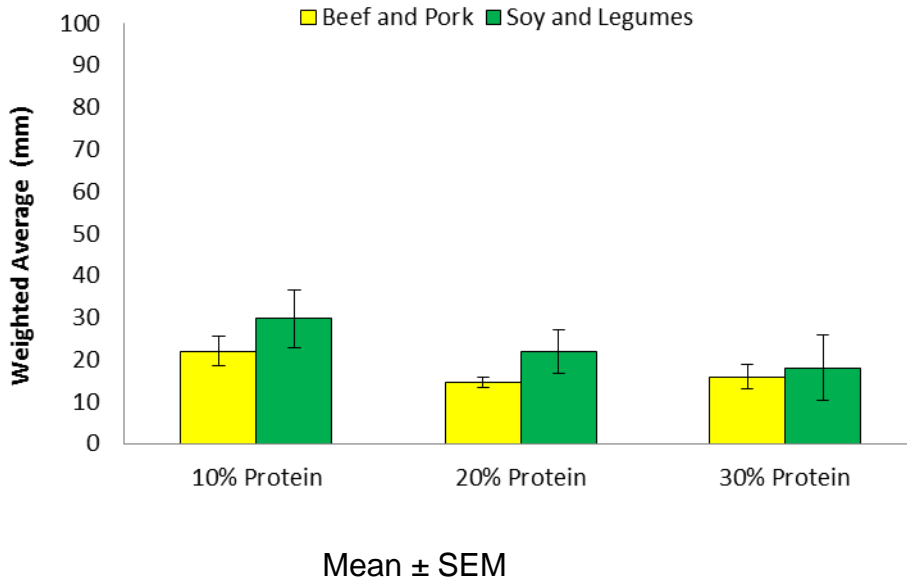
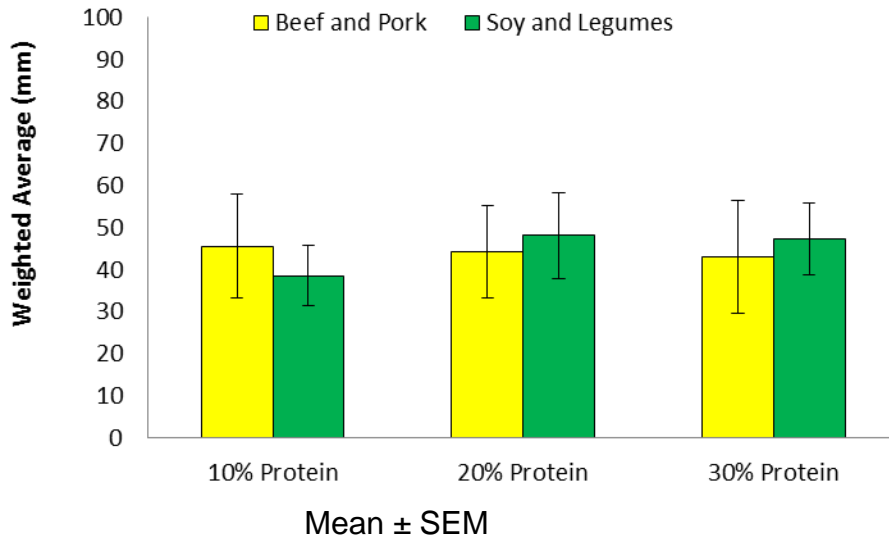
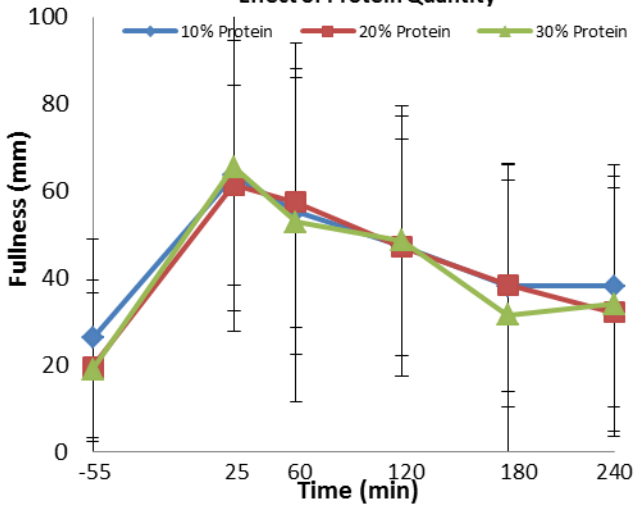


Figure 16: Postprandial fullness weighted average (A) and mean response (B and C) by predominate protein source and quantity.

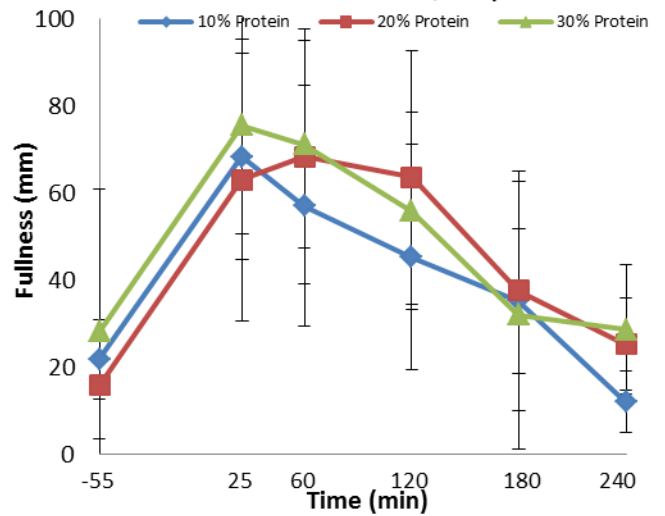
A
Perceived Postprandial Fullness Response



B
Postprandial Fullness Ratings of Beef & Pork Group
Effect of Protein Quantity



C
Postprandial Fullness Ratings of Soy & Legumes Group
Effect of Protein Quantity



Mood:

Postprandial total mood response (weighted averages) were negatively correlated ($r=-.40$, $p<0.05$) to postprandial total amino acid response (delta weighted average) (see Figure 17). Protein quantity and source did not affect postprandial total mood disturbance or the six POMS subcategories (vigor, fatigue, depression, confusion, tension, anger) mood responses (weighted averages) (see Figures 18-25).

Figure 17: Correlation between total mood and total amino acids.

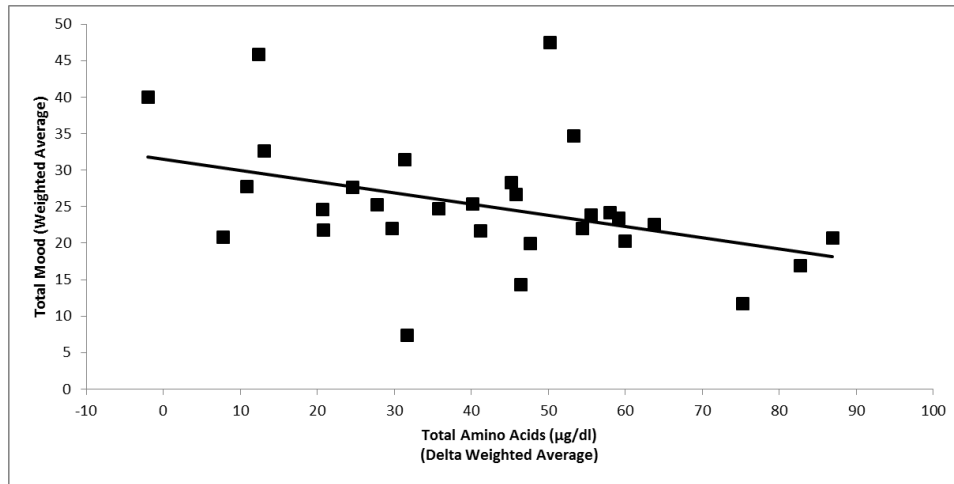


Figure 18: Profile of Mood States by total and POMS subcategory.

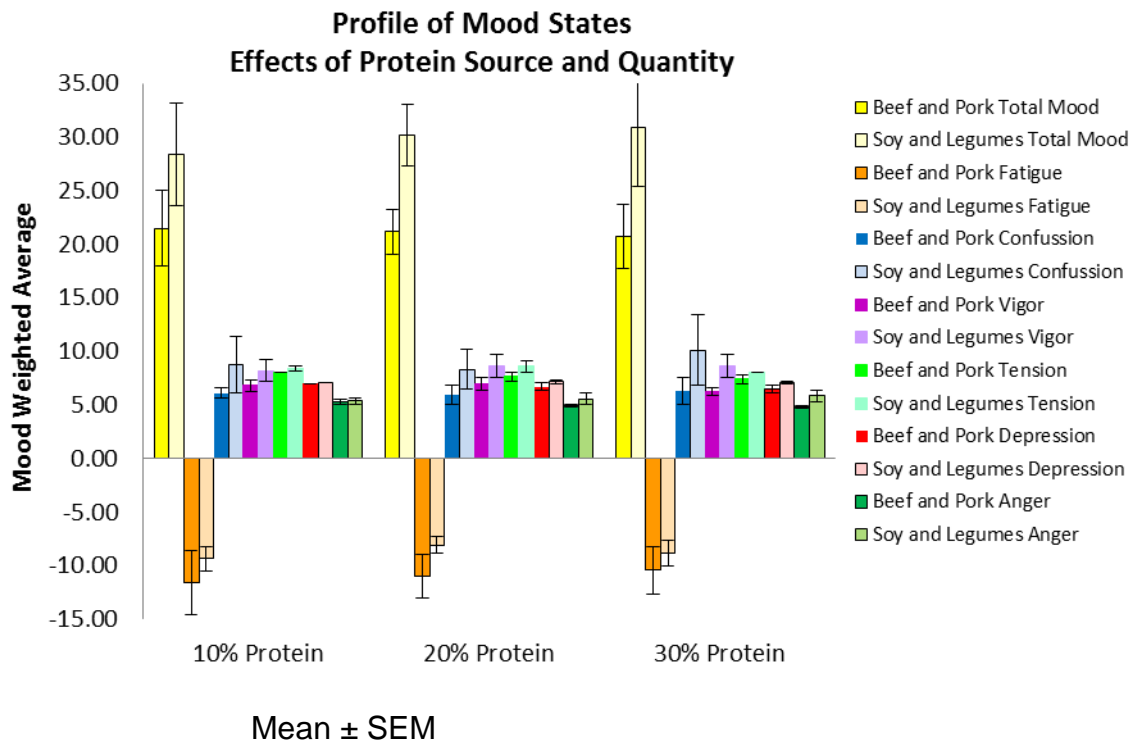


Figure 19: Total mood disturbance by predominate protein source and quantity.

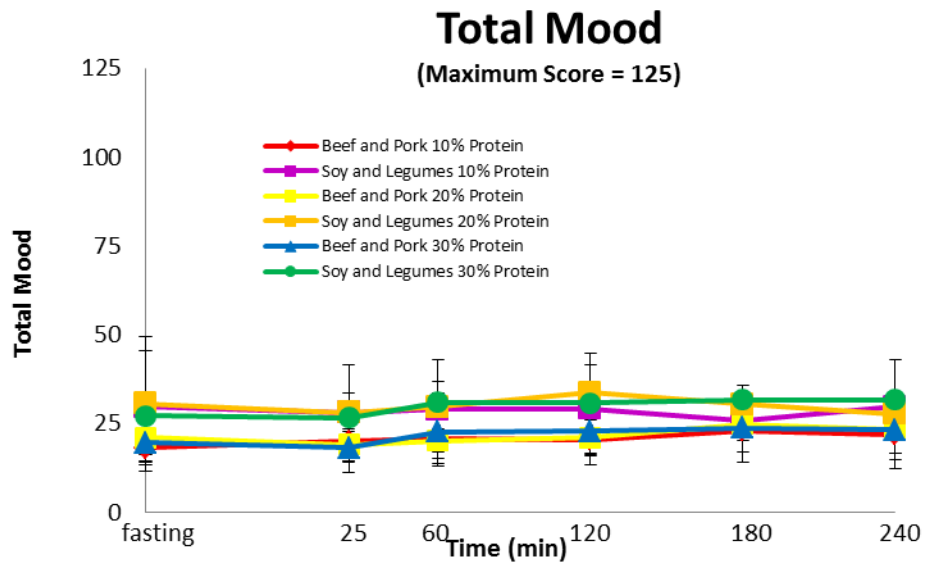


Figure 20: Fatigue response by predominate protein source and quantity.

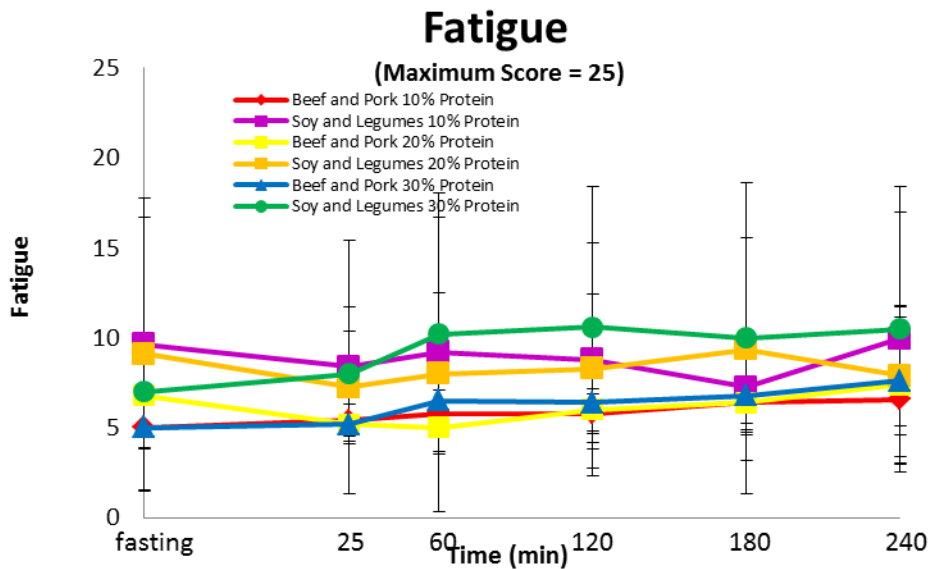


Figure 21: Confusion response by predominate protein source and quantity.

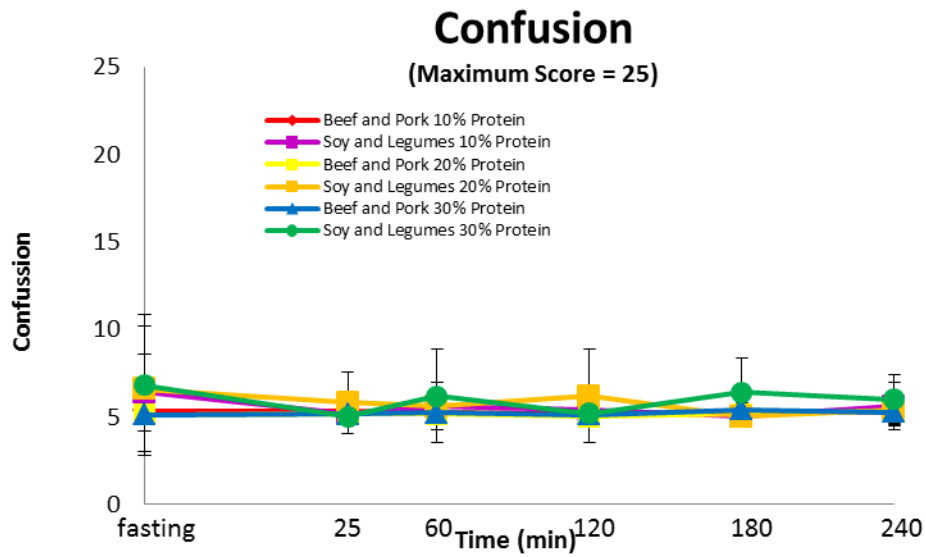


Figure 22: Vigor response by predominate protein source and quantity.

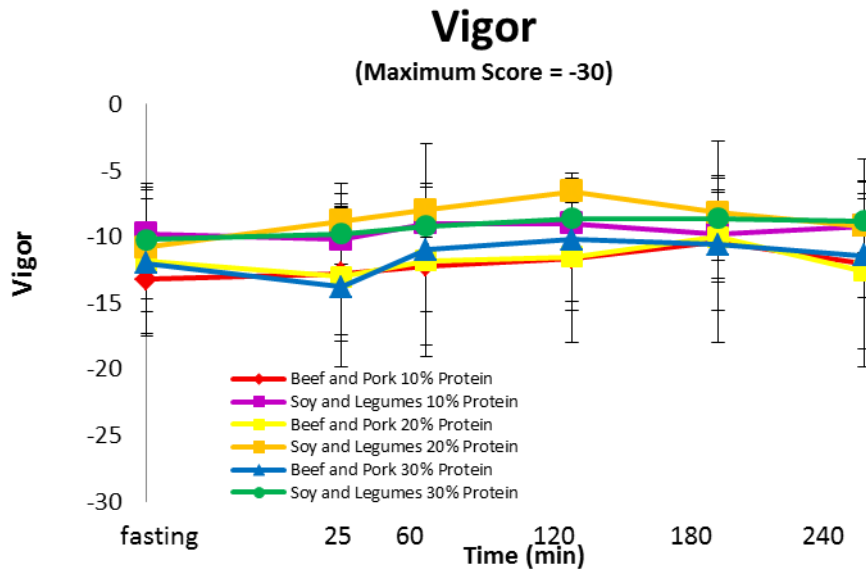


Figure 23: Tension response by predominate protein source and quantity.

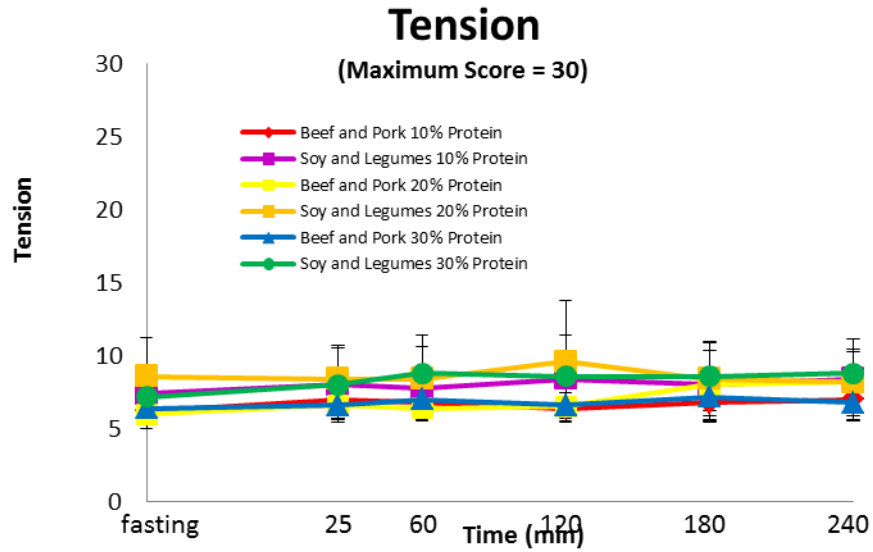


Figure 24: Depression response by predominate protein source and quantity.

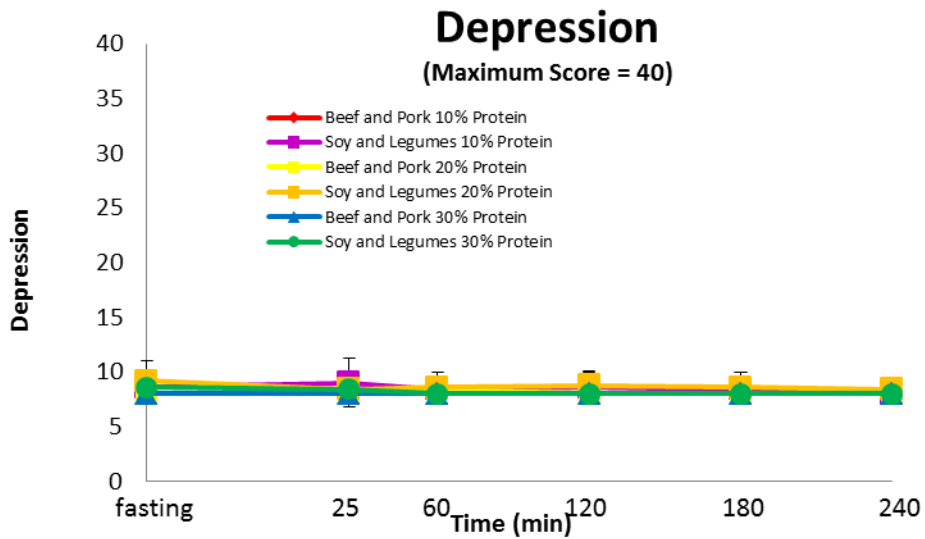
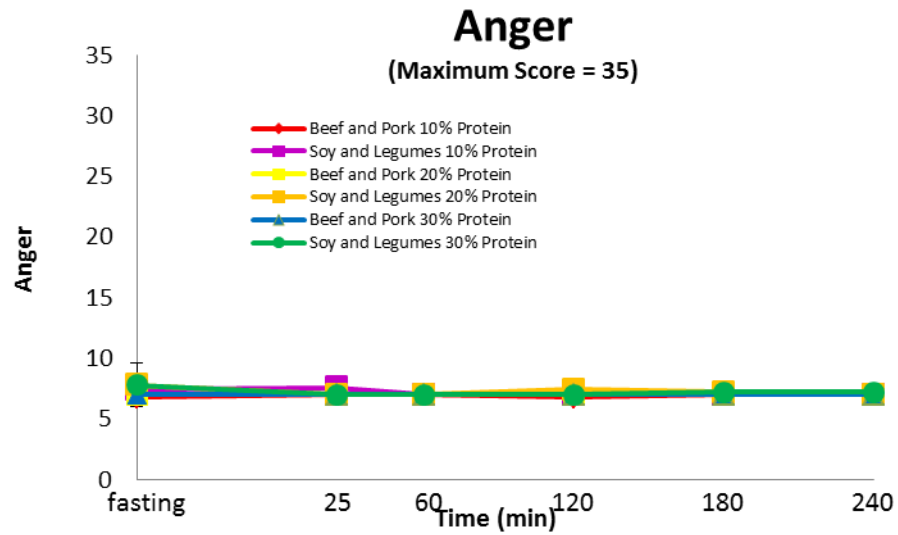


Figure 25: Anger response by predominate protein source and quantity.



Discussion:

The plasma BUN and amino acid data indicate that we successfully provided and the subjects were compliant consuming the different quantities of protein during each trial and testing day.

Aim 1: Plasma Amino Acid Concentrations - Hypothesis: Increasing protein content (esp. red meat vs. soy) will result in progressively greater and sustained plasma amino acid concentrations. The differential responses will not be different between the beef/pork and soy/pulses groups of subjects.

As hypothesized, the postprandial plasma amino acid responses were greater with increasing protein intake.

Aim 2: Satiety - Hypothesis: Increasing plasma amino acid concentrations (esp. red meat vs. soy) will result in progressively more robust/sustained changes in satiety (decreased hunger/desire to eat and increased fullness). The differential responses will not be different between the beef/pork and soy/pulses groups of subjects.

Contrary to expectation, the postprandial appetite responses were not progressively more robust when the meals containing 20% or 30% energy from protein were consumed compared to 10% energy from protein.

Contrary to expectation, the postprandial plasma amino acid responses were not correlated with the appetite responses. Assessment of these possible relationships was very likely hampered by the small sample size (n=5 per protein source group; n=10 total).

It is highly feasible for overweight/obese adults to successfully lose weight by consuming energy-restricted diets that contain 10 to 30 percent of energy from protein, with lean beef and pork as the predominant sources of protein.

These people experienced greater increases in plasma amino acids when they consumed greater amounts of protein in a meal, especially when the meal contained beef and pork vs. soy and pulses.

Higher protein intake from lean beef/pork and soy/pulses promoted greater reductions in hunger and desire to eat responses after a meal. Ingesting a meal with 30% of energy from protein was superior to when the meals contained 10 or 20% of energy from protein.

Consuming higher amounts of protein from lean beef and pork foods helps overweight and moderately obese adults curb their appetite (reduce their hunger) after eating.

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Appendix 1: 7-day Counseling Based Dietary Control Menus (bolded foods provided to subjects)

Beef and Pork – 10% Protein Menu

<i>Day 1</i>	<i>Day 2</i>	<i>Day 3</i>	<i>Day 4</i>	<i>Day 5</i>	<i>Day 6</i>	<i>Day 7</i>
<p>Breakfast Grapefruit Half Ham & Cheese Omelet Toast with Margarine & Jam Cranberry Beverage Coffee</p>	<p>Breakfast Fresh Grapes Strawberry Yogurt Light Orange Juice Coffee</p>	<p>Breakfast Banana Rice Krispies w/Skim Milk Blueberry Muffin with Margarine Cranberry Beverage Coffee</p>	<p>Breakfast Blueberries Pancakes with Syrup & Margarine Canadian Bacon Skim Milk Coffee</p>	<p>Breakfast Grapefruit Half Scrambled Eggs English Muffin with Margarine & Jam Cranberry Beverage Coffee</p>	<p>Breakfast Banana Bagel with Cream Cheese Light Orange Juice Coffee</p>	<p>Breakfast Blueberries Waffles with Syrup & Margarine Skim Milk Coffee</p>
<p>Lunch Roast Beef Sandwich with Cheese, Lettuce & Tomato, Mayonnaise Pringles Diced Pears Diet Soda</p>	<p>Lunch Spinach & Ham Quiche Fresh Baby Carrots with Vegetable Dip Fresh Apple Welch’s Fruit Snack Crystal Light</p>	<p>Lunch Chef Salad with Dressing (Ham, Cheese, and Egg) Wheat Thin Toasted Chips Mixed Fruit Cup Diet Soda</p>	<p>Lunch Pork Tenderloin Sandwich with Provolone Cheese, Lettuce & Tomato, Mayonnaise Harvest Cheddar Sun Chips Fruited Gelatin Crystal Light</p>	<p>Lunch Hard Beef Taco with Lettuce & Tomato Chips & Salsa Frozen Fruit Bar Diet Soda</p>	<p>Lunch Tomato Soup Grilled Ham & Cheese Sandwich Fresh Celery Sticks with Vegetable Dip Pringles Fresh Apple Crystal Light</p>	<p>Lunch Garden Salad with Dressing Ham & Pasta Carbanero Mixed Fruit Cup Crystal Light</p>
<p>Snack Hershey Almond Kisses Crystal Light</p>	<p>Snack Quaker Oats Granola Bar Diet Soda</p>	<p>Snack Whole Grain Goldfish Crystal Light</p>	<p>Snack 100 kcal Keebler Striped Cookies Diet Soda</p>	<p>Snack Quaker Oats Granola Bar Crystal Light</p>	<p>Snack Hershey Almond Kisses Diet Soda</p>	<p>Snack Whole Grain Goldfish Diet Soda</p>
<p>Dinner Garden Salad with Dressing Roast Pork Tenderloin Candied Sweet Potatoes with Mini Marshmallows Green Beans Dinner Roll with Margarine Fruited Gelatin with Whipped Topping Ice Tea</p>	<p>Dinner Southwestern Beef Salad with Lettuce, Tomato, Ranch Dressing and Salsa Fritos Mandarin Oranges Frozen Fruit Bar Ice Tea</p>	<p>Dinner Roast Beef Tenderloin Mashed Potatoes with Gravy Carrots Dinner Roll with Margarine Yellow Cake with Fruit Topping Ice Tea</p>	<p>Dinner Caesar Salad with Dressing Spaghetti & Beefsauce Garlic Toast Fresh Grapes Lemon Sorbet Ice Tea</p>	<p>Dinner Sliced Ham Roasted Red Potatoes Broccoli, Cauliflower & Carrots in Cheese Sauce Dinner Roll with Margarine Apple Crisp Ice Tea</p>	<p>Dinner BBQ Beef Brisket Mashed Potatoes Whole Kernel Corn Vanilla Ice Cream with Fruit Topping Ice Tea</p>	<p>Dinner Asian Beef Stir fry Brown Rice Pineapple Pecan Sandies Ice Tea</p>
<p>Snack Klondike Slim-a-Bear Ice Cream Sandwich Water</p>	<p>Snack 100 kcal Jell-O Pudding Water</p>	<p>Snack Smartfood Cheese Popcorn Diet Soda</p>	<p>Snack Klondike Slim-a-Bear Ice Cream Sandwich Water</p>	<p>Snack 100 kcal Jell-O Pudding Water</p>	<p>Snack Smartfood Cheese Popcorn Diet Soda</p>	<p>Snack 100 kcal Jell-O Pudding Water</p>

Beef and Pork – 20% Protein Menu

<i>Day 1</i>	<i>Day 2</i>	<i>Day 3</i>	<i>Day 4</i>	<i>Day 5</i>	<i>Day 6</i>	<i>Day 7</i>
<p>Breakfast Grapefruit Half Ham and Cheese Omelet Canadian Bacon Toast with Jam Cranberry Beverage Coffee</p>	<p>Breakfast Fresh Grapes Strawberry Yogurt with Granola Light Orange Juice Coffee</p>	<p>Breakfast Banana Special K w/Skim Milk Blueberry Muffin Canadian Bacon Cranberry Beverage Coffee</p>	<p>Breakfast Blueberries Pancakes with Diet Syrup Canadian Bacon Skim Milk Coffee</p>	<p>Breakfast Grapefruit Half Scrambled Eggs Canadian Bacon English Muffin with Jam Cranberry Beverage Coffee</p>	<p>Breakfast Banana Bagel with Cream Cheese Canadian Bacon Light Orange Juice Skim Milk Coffee</p>	<p>Breakfast Blueberries Waffles with Diet Syrup Canadian Bacon Skim Milk Coffee</p>
<p>Lunch Roast Beef Sandwich with Cheese, Lettuce & Tomato, Mayonnaise Pringles Diced Pears Diet Soda</p>	<p>Lunch Spinach & Ham Quiche Fresh Baby Carrots with Vegetable Dip Fresh Apple Crystal Light</p>	<p>Lunch Chef Salad with Dressing (Ham, Cheese, and Egg) Melba Rounds Mixed Fruit Cup Diet Soda</p>	<p>Lunch Pork Tenderloin Sandwich with Provolone Cheese, Lettuce & Tomato, Mayonnaise Harvest Cheddar Sun Chips Sugar Free Gelatin Crystal Light</p>	<p>Lunch Soft Beef Taco with Lettuce, Tomato & Cheese Chips & Salsa Frozen Fruit Bar Diet Soda</p>	<p>Lunch Cream of Tomato Soup Grilled Ham & Cheese Sandwich Fresh Celery Sticks with Vegetable Dip Pringles Sugar Free Gelatin Crystal Light</p>	<p>Lunch Garden Salad with Dressing Ham & Pasta Carbanero Mixed Fruit Cup Crystal Light</p>
<p>Snack Cocoa Roasted Almonds Crystal Light</p>	<p>Snack Homemade Granola Diet Soda</p>	<p>Snack Cheese Twist Crackers Crystal Light</p>	<p>Snack Kroger Traditional Chex Mix Diet Soda</p>	<p>Snack Homemade Granola Crystal Light</p>	<p>Snack Cocoa Roasted Almonds Diet Soda</p>	<p>Snack Cheese Twist Crackers Diet Soda</p>
<p>Dinner Garden Salad with Dressing Roast Pork Tenderloin Candied Sweet Potatoes with Mini Marshmallows Green Beans Dinner Roll with Margarine Sugar Free Gelatin with Whipped Topping Ice Tea</p>	<p>Dinner Southwestern Beef Salad with Lettuce, Cheese, & Salsa Fritos Mandarin Oranges Frozen Fruit Bar Ice Tea</p>	<p>Dinner Roast Beef Tenderloin Sautéed Mushrooms Mashed Potatoes with Gravy Broccoli Spears Dinner Roll with Margarine Angle Food Cake with Fruit Topping Ice Tea</p>	<p>Dinner Caesar Salad with Dressing Spaghetti & Beefsauce Green Beans Garlic Toast Lemon Sorbet Ice Tea</p>	<p>Dinner Sliced Ham Roasted Red Potatoes Broccoli, Cauliflower & Carrots in Cheese Sauce Dinner Roll with Margarine Apple Crisp Ice Tea</p>	<p>Dinner BBQ Beef Brisket Mashed Potatoes Whole Kernel Corn Dinner Roll with Margarine Vanilla Ice Cream with Fruit Topping Ice Tea</p>	<p>Dinner Asian Beef Stir fry Brown Rice Fresh Pineapple Pecan Sandies Ice Tea</p>
<p>Snack Skinny Cow Truffle Bar Water</p>	<p>Snack Sugar Free Jell-O Pudding Water</p>	<p>Snack Microwave Popcorn Diet Soda</p>	<p>Snack Skinny Cow Truffle Bar Water</p>	<p>Snack Sugar Free Jell-O Pudding Water</p>	<p>Snack Microwave Popcorn Diet Soda</p>	<p>Snack Sugar Free Jell-O Pudding Water</p>

Beef and Pork – 30% Protein Menu

<i>Day 1</i>	<i>Day 2</i>	<i>Day 3</i>	<i>Day 4</i>	<i>Day 5</i>	<i>Day 6</i>	<i>Day 7</i>
<p>Breakfast Grapefruit Sections Southwestern Scrambled Eggs with Cheese Canadian Bacon Whole Wheat Toast & Jam Cranberry Beverage Coffee</p>	<p>Breakfast Yogurt with Almonds, Wheat Germ & Cranberries Naked Very Berry Juice Coffee</p>	<p>Breakfast Melon Balls Cottage Cheese with Jam Blueberry Muffin Canadian Bacon Cranberry Beverage Coffee</p>	<p>Breakfast Raspberries with Yogurt Pancakes with Diet Syrup Canadian Bacon Naked Very Berry Juice Coffee</p>	<p>Breakfast Grapefruit Sections Southwestern Scrambled Eggs with Cheese Canadian Bacon English Muffin & Jam Cranberry Beverage Coffee</p>	<p>Breakfast Yogurt with Almonds, Wheat Germ & Cranberries Naked Very Berry Juice Coffee</p>	<p>Breakfast Raspberries with Yogurt Pancakes with Diet Syrup Canadian Bacon Naked Very Berry Juice Coffee</p>
<p>Lunch Roast Beef Wrap with Lettuce, Spinach, Red Pepper, Cheese & Tomato Light Ranch Dressing Pretzels Naked Very Berry Juice Diet Soda</p>	<p>Lunch Spinach & Ham Quiche Fresh Baby Carrots with Vegetable Dip Cottage Cheese & Peaches Crystal Light</p>	<p>Lunch Garden Vegetable Soup Chef Salad with Dressing (Ham, Cheese and Egg) Sesame Crackers Sugar Free Gelatin Diet Soda</p>	<p>Lunch Pork Tenderloin Wrap with Lettuce, Spinach, Red Pepper, Cheese & Tomato Light Ranch Dressing Pretzels Philly Swirl Cream Pop Crystal Light</p>	<p>Lunch Beef Fajita Salad Chips & Salsa Mandarin Oranges Sugar Free Popsicle Diet Soda</p>	<p>Lunch Cream of Tomato Soup Grilled Ham Sandwich Fresh Celery Sticks with Vegetable Dip Sugar Free Gelatin Crystal Light</p>	<p>Lunch Spinach Salad with Dressing Ham & Pasta Primavera Philly Swirl Cream Pop Crystal Light</p>
<p>Snack Cheese and Crackers Crystal Light</p>	<p>Snack Homemade Granola Diet Soda</p>	<p>Snack Pumpkin Seed Crackers Crystal Light</p>	<p>Snack Pasta Chips Diet Soda</p>	<p>Snack Homemade Granola Crystal Light</p>	<p>Snack Cheese and Crackers Diet Soda</p>	<p>Snack Pumpkin Seed Crackers Diet Soda</p>
<p>Dinner Garden Salad with Dressing Roast Pork Tenderloin Candied Sweet Potatoes with Mini Marshmallows Asparagus Whole Wheat Bread with Margarine Sugar Free Gelatin with Whipped Topping Ice Tea</p>	<p>Dinner Southwestern Beef Salad with Lettuce, Spinach, Cheese & Salsa Fritos Mandarin Oranges Sugar Free Popsicle Ice Tea</p>	<p>Dinner Roast Beef Tenderloin Sautéed Mushrooms Mashed Potatoes with Gravy Broccoli Spears Whole Wheat Bread with Margarine Angel Food Cake Ice Tea</p>	<p>Dinner Caesar Salad with Dressing Spaghetti & Beefsauce Brussels Sprouts Garlic Toast Melon Balls Ice Tea</p>	<p>Dinner Sliced Ham Parmesan Red Potatoes Broccoli, Cauliflower & Carrots w/ Cheese Sauce Whole Wheat Bread Pineapple Chunks Ice Tea</p>	<p>Dinner BBQ Beef Brisket Mashed Potatoes Brussels Sprouts Whole Wheat Bread with Margarine Vanilla Ice Cream Ice Tea</p>	<p>Dinner Asian Beef Stir fry Soba Noodles Pineapple Chunks Sugar Free Shortbread Cookies Ice Tea</p>
<p>Snack Frozen Fruit Smoothie Water</p>	<p>Snack Sugar Free Jell-O Pudding Water</p>	<p>Snack Cheesy Herb Popcorn Diet Soda</p>	<p>Snack Frozen Fruit Smoothie Water</p>	<p>Snack Sugar Free Jell-O Pudding Water</p>	<p>Snack Cheesy Herb Popcorn Diet Soda</p>	<p>Snack Sugar Free Jell-O Pudding Water</p>

Soy and Legumes – 10% Protein Menu

<i>Day 1</i>	<i>Day 2</i>	<i>Day 3</i>	<i>Day 4</i>	<i>Day 5</i>	<i>Day 6</i>	<i>Day 7</i>
<p>Breakfast Grapefruit Half Southwestern Cheese Omelet Morningstar Organic Breakfast Pattie Toast with Margarine & Jam Cranberry Beverage Coffee</p>	<p>Breakfast Fresh Grapes Strawberry Yogurt Light Orange Juice Coffee</p>	<p>Breakfast Banana Rice Krispies with Skim Milk Blueberry Muffin with Margarine Cranberry Beverage Coffee</p>	<p>Breakfast Blueberries Pancakes with Syrup & Margarine Morningstar Organic Breakfast Pattie Skim Milk Coffee</p>	<p>Breakfast Grapefruit Half Scrambled Eggs English Muffin with Margarine & Jam Cranberry Beverage Coffee</p>	<p>Breakfast Banana Bagel with Cream Cheese Light Orange Juice Coffee</p>	<p>Breakfast Blueberries Waffles with Syrup & Margarine Skim Milk Coffee</p>
<p>Lunch Tofurky “Philly Steak” Sandwich with Cheese, Lettuce & Tomato Mayonnaise Pringles Diced Pears Diet Soda</p>	<p>Lunch Spinach & Morningstar Sausage Crumbles Quiche Fresh Baby Carrots with Vegetable Dip Fresh Apple Welch’s Fruit Snack Crystal Light</p>	<p>Lunch Chef Salad with Dressing (Tofurky “Hickory Smoked”, Cheese, and Egg) Wheat Thin Toasted Chips Mixed Fruit Cup Diet Soda</p>	<p>Lunch Tofurky “Italian” Sandwich with Provolone Cheese, Lettuce & Tomato, Mayonnaise Harvest Cheddar Sun Chips Fruited Gelatin Crystal Light</p>	<p>Lunch Hard Taco with Morningstar Sausage Crumbles, Lettuce & Tomato Chips & Salsa Frozen Fruit Bar Diet Soda</p>	<p>Lunch Tomato Soup Grilled Tofurky “Hickory Smoked” & Cheese Sandwich Fresh Celery Sticks with Vegetable Dip Pringles Fresh Apple Crystal Light</p>	<p>Lunch Garden Salad with Dressing Morningstar “Italian Sausage” and Pasta Carbanero Mixed Fruit Cup Crystal Light</p>
<p>Snack Reese Pieces Crystal Light</p>	<p>Snack Quaker Oats Granola Bar Diet Soda</p>	<p>Snack Whole Grain Goldfish Crystal Light</p>	<p>Snack 100 kcal Nabisco Peanut Butter Cookie Crisps Diet Soda</p>	<p>Snack Quaker Oats Granola Bar Crystal Light</p>	<p>Snack Reese Pieces Diet Soda</p>	<p>Snack Whole Grain Goldfish Diet Soda</p>
<p>Dinner Garden Salad with Dressing Lightlife Chick’n Cutlet Candied Sweet Potatoes with Mini Marshmallows Green Peas Dinner Roll with Margarine Fruited Gelatin with Whipped Topping Ice Tea</p>	<p>Dinner Southwestern Lightlife “Steak Strips” Salad with Lettuce, Tomato, Salsa, and Edamame Fritos Mandarin Oranges Frozen Fruit Bar Ice Tea</p>	<p>Dinner Boca Classic Burger Pattie Mashed Potatoes with Gravy Carrots Dinner Roll with Margarine Lemon Cake with Fruit Topping Ice Tea</p>	<p>Dinner Caesar Salad with Dressing Spaghetti & Morningstar Sausage Crumbles Sauce Garlic Toast Fresh Grapes Lemon Sorbet Ice Tea</p>	<p>Dinner Lightlife Chick’n Cutlet Roasted Red Potatoes Broccoli, Cauliflower & Carrots in Cheese Sauce Dinner Roll with Margarine Apple Crisp Ice Tea</p>	<p>Dinner Boca Classic Burger Pattie Barbeque Sauce Mashed Potatoes Three Bean Salad Vanilla Ice Cream with Fruit Topping Ice Tea</p>	<p>Dinner Asian Lightlife “Steak Strips” Stir fry with Edamame Brown Rice Pineapple Pecan Sandies Ice Tea</p>
<p>Snack Klondike Slim-a-Bear Ice Cream Sandwich Water</p>	<p>Snack 100 kcal Jell-O Pudding Water</p>	<p>Snack Smartfood Cheese Popcorn Diet Soda</p>	<p>Snack Klondike Slim-a-Bear Ice Cream Sandwich Water</p>	<p>Snack 100 kcal Jell-O Pudding Water</p>	<p>Snack Smartfood Cheese Popcorn Diet Soda</p>	<p>Snack 100 kcal Jell-O Pudding Water</p>

Soy and Legume – 20% Protein Menu

<i>Day 1</i>	<i>Day 2</i>	<i>Day 3</i>	<i>Day 4</i>	<i>Day 5</i>	<i>Day 6</i>	<i>Day 7</i>
<p>Breakfast Grapefruit Half Southwestern Cheese Omelet Morningstar Organic Breakfast Pattie Toast with Jam Cranberry Beverage Coffee</p>	<p>Breakfast Fresh Grapes Strawberry Yogurt with Granola Light Orange Juice Coffee</p>	<p>Breakfast Banana Special K w/Skim Milk Blueberry Muffin Morningstar Organic Breakfast Pattie Cranberry Beverage Coffee</p>	<p>Breakfast Blueberries Pancakes with Diet Syrup Morningstar Organic Breakfast Pattie Skim Milk Coffee</p>	<p>Breakfast Grapefruit Half Scrambled Eggs Morningstar Organic Breakfast Pattie English Muffin with Jam Cranberry Beverage Coffee</p>	<p>Breakfast Banana Bagel with Cream Cheese Morningstar Organic Breakfast Pattie Light Orange Juice Skim Milk Coffee</p>	<p>Breakfast Blueberries Waffles with Diet Syrup Morningstar Organic Breakfast Pattie Skim Milk Coffee</p>
<p>Lunch Tofurky “Philly Steak” Sandwich with Cheese, Lettuce & Tomato, Mayonnaise Pringles Diced Pears Diet Soda</p>	<p>Lunch Spinach & Morningstar Sausage Crumbles Quiche Fresh Baby Carrots with Vegetable Dip Fresh Apple Crystal Light</p>	<p>Lunch Chef Salad with Dressing (Tofurky “Hickory Smoked”, Cheese, & Egg) Melba Rounds Mixed Fruit Cup Diet Soda</p>	<p>Lunch Tofurky “Italian” Sandwich with Cheese, Lettuce & Tomato, Mayonnaise Harvest Cheddar Sun Chips Sugar Free Gelatin Crystal Light</p>	<p>Lunch Soft Taco with Morningstar Sausage Crumbles with Lettuce, Tomato, & Cheese Chips & Salsa Frozen Fruit Bar Diet Soda</p>	<p>Lunch Cream of Tomato Soup Grilled Tofurky “Hickory Smoked” & Cheese Sandwich Fresh Celery Sticks with Vegetable Dip Pringles Sugar Free Gelatin Crystal Light</p>	<p>Lunch Garden Salad with Dressing Morningstar “Italian Sausage” & Pasta Carbanero Mixed Fruit Cup Crystal Light</p>
<p>Snack Peanut Goobers Crystal Light</p>	<p>Snack Homemade Granola Diet Soda</p>	<p>Snack Cheese Twist Crackers Crystal Light</p>	<p>Snack Kroger Traditional Chex Mix Diet Soda</p>	<p>Snack Homemade Granola Crystal Light</p>	<p>Snack Peanut Goobers Diet Soda</p>	<p>Snack Cheese Twist Crackers Diet Soda</p>
<p>Dinner Garden Salad with Dressing Lightlife Chick’n Cutlet Candied Sweet Potatoes with Mini Marshmallows Green Peas Dinner Roll with Margarine Sugar Free Gelatin with Whipped Topping Ice Tea</p>	<p>Dinner Southwestern Lightlife “Steak Strips” Salad with Lettuce, Cheese, Salsa Ranch Dressing, and Edamame Fritos Mandarin Oranges Frozen Fruit Bar Ice Tea</p>	<p>Dinner Boca Classic Burger Pattie Sautéed Mushrooms Mashed Potatoes with Gravy Broccoli Dinner Roll with Margarine Angel Food Cake with Fruit Topping Ice Tea</p>	<p>Dinner Caesar Salad with Dressing Spaghetti & Morningstar Sausage Crumbles Sauce Green Beans Garlic Toast Lemon Sorbet Ice Tea</p>	<p>Dinner Lightlife Chick’n Cutlet Roasted Red Potatoes Broccoli, Cauliflower & Carrots in Cheese Sauce Dinner Roll Apple Crisp Ice Tea</p>	<p>Dinner Boca Classic Burger Pattie Barbeque Sauce Mashed Potatoes Three Bean Salad Dinner Roll with Margarine Vanilla Ice Cream with Fruit Topping Ice Tea</p>	<p>Dinner Asian Lightlife “Steak Strips” Stir fry with Edamame Soba Noodles Fresh Pineapple Peanut Butter Cookie Crisps Ice Tea</p>
<p>Snack Skinny Cow Truffle Bar Water</p>	<p>Snack Sugar Free Jell-O Pudding Water</p>	<p>Snack Microwave Popcorn Diet Soda</p>	<p>Snack Skinny Cow Truffle Bar Water</p>	<p>Snack Sugar Free Jell-O Pudding Water</p>	<p>Snack Microwave Popcorn Diet Soda</p>	<p>Snack Sugar Free Jell-O Pudding Water</p>

Soy and Legume – 30% Protein Menu

<i>Day 1</i>	<i>Day 2</i>	<i>Day 3</i>	<i>Day 4</i>	<i>Day 5</i>	<i>Day 6</i>	<i>Day 7</i>
<p>Breakfast Grapefruit Sections Southwestern Scrambled Eggs with Cheese Morningstar Organic Breakfast Pattie Whole Wheat Toast & Jam Cranberry Beverage Coffee</p>	<p>Breakfast Yogurt with Almonds, Wheat Germ & Cranberries Naked Very Berry Juice Coffee</p>	<p>Breakfast Melon Balls Cottage Cheese with Jam Blueberry Muffin Morningstar Organic Breakfast Pattie Cranberry Beverage Coffee</p>	<p>Breakfast Raspberries with Yogurt Pancakes with Diet Syrup Morningstar Organic Breakfast Pattie Naked Very Berry Juice Coffee</p>	<p>Breakfast Grapefruit Sections Southwestern Scrambled Eggs with Cheese Morningstar Organic Breakfast Pattie English Muffin & Jam Cranberry Beverage Coffee</p>	<p>Breakfast Yogurt with Almonds, Wheat Germ & Cranberries Naked Very Berry Juice Coffee</p>	<p>Breakfast Raspberries with Yogurt Pancakes with Diet Syrup Morningstar Organic Breakfast Pattie Naked Very Berry Juice Coffee</p>
<p>Lunch Tofurky “Philly Steak” Wrap with Lettuce, Spinach, Red Pepper, Cheese & Tomato Light Ranch Dressing Pretzels Naked Very Berry Juice Diet Soda</p>	<p>Lunch Spinach & Morningstar Sausage Crumbles Quiche Fresh Baby Carrots with Vegetable Dip Cottage Cheese & Peaches Crystal Light</p>	<p>Lunch Garden Vegetable Soup Chef Salad with Dressing (Tofurky “Hickory Smoked”, Cheese, Soynuts, and Egg) Sesame Crackers Sugar Free Gelatin Diet Soda</p>	<p>Lunch Tofurky “Italian” Wrap with Lettuce, Spinach, Red Pepper, Cheese & Tomato Light Ranch Dressing Pretzels Crystal Light</p>	<p>Lunch Morningstar Sausage Crumbles Fajita Salad Chips & Salsa Mandarin Oranges Diet Soda</p>	<p>Lunch Cream of Tomato Soup Grilled Tofurky “Hickory Smoked Sandwich Fresh Celery Sticks with Vegetable Dip Sugar Free Gelatin Crystal Light</p>	<p>Lunch Spinach Salad with Dressing and Soynuts Morningstar “Italian Sausage” & Pasta Primavera Crystal Light</p>
<p>Snack Cheese and Crackers Crystal Light</p>	<p>Snack Homemade Granola Diet Soda</p>	<p>Snack Pumpkin Seed Crackers Crystal Light</p>	<p>Snack Pasta Chips Diet Soda</p>	<p>Snack Homemade Granola Crystal Light</p>	<p>Snack Cheese and Crackers Diet Soda</p>	<p>Snack Pumpkin Seed Crackers Diet Soda</p>
<p>Dinner Garden Salad with Dressing and Soynuts Lightlife Chick’n Cutlet Candied Sweet Potatoes with Mini Marshmallows Asparagus Whole Wheat Bread with Margarine Sugar Free Gelatin with Whipped Topping Ice Tea</p>	<p>Dinner Southwestern Lightlife “Steak Strips” Salad with Lettuce, Spinach, Cheese Edamame & Salsa Fritos Mandarin Oranges Ice Tea</p>	<p>Dinner Boca Classic Burger Pattie Sautéed Mushrooms Mashed Potatoes with Gravy Broccoli Spears Whole Wheat Bread with Margarine Angel Food Cake Ice Tea</p>	<p>Dinner Caesar Salad with Dressing Spaghetti & Morningstar Sausage Crumbles Sauce Brussels Sprouts Melon Balls Ice Tea</p>	<p>Dinner Lightlife Chick’n Cutlet Parmesan Red Potatoes Broccoli, Cauliflower & Carrots w/ Cheese Sauce Whole Wheat Bread Pineapple Chunks Ice Tea</p>	<p>Dinner Boca Classic Burger Pattie Barbeque Sauce Mashed Potatoes Brussels Sprouts Whole Wheat Bread with Margarine Vanilla Ice Cream Ice Tea</p>	<p>Dinner Asian Lightlife “Steak Strips” Stir fry with Edamame Soba Noodles Pineapple Chunks Sugar Free Shortbread Cookie Ice Tea</p>
<p>Snack Frozen Fruit Smoothie Water</p>	<p>Snack Sugar Free Jell-O Pudding Water</p>	<p>Snack Cheesy Herb Popcorn Diet Soda</p>	<p>Snack Frozen Fruit Smoothie Water</p>	<p>Snack Sugar Free Jell-O Pudding Water</p>	<p>Snack Cheesy Herb Popcorn Diet Soda</p>	<p>Snack Sugar Free Jell-O Pudding Water</p>

Appendix 2: 3-day Controlled Menus – All Foods Provided to Subjects

Beef and Pork – 10% Protein Menu

<i>Day 25</i>	<i>Day 26</i>	<i>Day 27</i>
<p>Breakfast Tropical Fruit Salad Western Omelet with Canadian Bacon & Cheese Toast with Margarine & Jam Capri Sun - Sunrise Coffee</p>	<p>Breakfast Cantaloupe & Honeydew Melon Lemon Poppyseed Muffin Fruited Yogurt Apple Juice Coffee</p>	<p>Breakfast Ham & Cheese Biscuit Potatoes O'Brien Capri Sun – Tropical Fruit Coffee</p>
<p>Lunch Mini Chef Salad with Dressing Ham & Cheese Pizza Fruit Snack Diet Soda</p>	<p>Lunch Cream of Broccoli Soup Ham Salad on Whole Wheat Crackers Fresh Apple Raisins Crystal Light</p>	<p>Lunch Beef & Cheese Enchilada Chips & Salsa Fresh Grapes Diet Soda</p>
<p>Snack Yogurt Covered Raisins Crystal Light</p>	<p>Snack Hershey Almond Nuggets Diet Soda</p>	<p>Snack Pretzels with Cheese Dip Crystal Light</p>
<p>Dinner Beef Stroganoff Broccoli Spears Dinner Roll with Margarine Peach Crisp Ice Tea</p>	<p>Dinner Salisbury Steak & Gravy Mashed Potatoes Green Beans Pineapple Upside down Cake Ice Tea</p>	<p>Dinner Asian Pork Stir fry Brown Rice Mandarin Oranges Gingersnap Cookies Ice Tea</p>
<p>Snack Pears with Cottage Cheese Water</p>	<p>Snack Caramel Flavored Rice Cakes Diet Soda</p>	<p>Snack Jell-O Chocolate Mousse Devil's Food Cookie Water</p>

Beef and Pork – 20% Protein Menu

<i>Day 25</i>	<i>Day 26</i>	<i>Day 27</i>
<p><i>Breakfast</i> Tropical Fruit Salad Western Omelet with Canadian Bacon & Cheese Toast with Jam Capri Sun - Sunrise Coffee</p>	<p><i>Breakfast</i> Cantaloupe & Honeydew Melon Lemon Poppyseed Muffin Fruited Yogurt Light Orange Juice Coffee</p>	<p><i>Breakfast</i> Ham & Cheese Biscuit Potatoes O'Brien Capri Sun – Tropical Fruit Coffee</p>
<p><i>Lunch</i> Mini Chef Salad with Dressing Ham, Mushroom & Cheese Pizza Fruit Snack Diet Soda</p>	<p><i>Lunch</i> Cream of Broccoli Soup Ham Salad on Flatbread Crisps Fresh Apple Crystal Light</p>	<p><i>Lunch</i> Beef & Cheese Enchilada Chips & Salsa Fresh Grapes Diet Soda</p>
<p><i>Snack</i> Pretzels with Ranch Dip Crystal Light</p>	<p><i>Snack</i> Cinnamon Brown Sugar Almonds Diet Soda</p>	<p><i>Snack</i> Homemade Granola Crystal Light</p>
<p><i>Dinner</i> Beef Stroganoff Broccoli Spears Dinner Roll with Margarine Peach Crisp Ice Tea</p>	<p><i>Dinner</i> Salisbury Steak & Gravy Mashed Potatoes Green Beans Almondine Dinner Roll Pineapple Upside down Cake Ice Tea</p>	<p><i>Dinner</i> Asian Pork Stir fry Soba Noodles Mandarin Oranges Gingersnap Cookies Ice Tea</p>
<p><i>Snack</i> Pears with Cottage Cheese Water</p>	<p><i>Snack</i> Cheesy Herb Popcorn Diet Soda</p>	<p><i>Snack</i> Chocolate Mousse with Oreo Crumbs Water</p>

Beef and Pork – 30% Protein Menu

<i>Day 25</i>	<i>Day 26</i>	<i>Day 27</i>
<p><i>Breakfast</i> Tropical Fruit Salad Western Omelet with Canadian Bacon & Cheese Toast with Jam V8 Juice Coffee</p>	<p><i>Breakfast</i> Blackberries Lemon Poppyseed Muffin Fruited Yogurt with Wheat Germ Carroty Orange Juice Coffee</p>	<p><i>Breakfast</i> Ham & Cheese Biscuit Potatoes O'Brien Naked Very Berry Juice Coffee</p>
<p><i>Lunch</i> Mini Chef Salad with Dressing Ham, Mushroom & Cheese Pizza Sugar Free Gelatin Diet Soda</p>	<p><i>Lunch</i> Cream of Broccoli Soup Ham Sandwich with Lettuce, Cheese, Tomato and Mustard Crystal Light</p>	<p><i>Lunch</i> Beef & Cheese Enchilada Chips & Salsa Sugar Free Gelatin Diet Soda</p>
<p><i>Snack</i> Pretzels with Ranch Dip Crystal Light</p>	<p><i>Snack</i> Cheesy Herb Popcorn Diet Soda</p>	<p><i>Snack</i> Homemade Granola Crystal Light</p>
<p><i>Dinner</i> Beef Stroganoff Asparagus Spears Whole Wheat Bread with Margarine Peach Crisp Ice Tea</p>	<p><i>Dinner</i> Salisbury Steak & Gravy Mashed Potatoes Green Beans Almondine Whole Wheat Bread Pineapple Chunks Ice Tea</p>	<p><i>Dinner</i> Asian Pork Stir fry Soba Noodles Mandarin Oranges Ice Tea</p>
<p><i>Snack</i> Pears with Cottage Cheese Water</p>	<p><i>Snack</i> Frozen Smoothie Diet Soda</p>	<p><i>Snack</i> Chocolate Mousse Water</p>

Soy & Legume – 10% Protein Menu

<i>Day 25</i>	<i>Day 26</i>	<i>Day 27</i>
<p><i>Breakfast</i> Tropical Fruit Salad Western Omelet with Cheese & Morningstar Sausage Crumbles Toast with Margarine & Jam Capri Sun - Sunrise Coffee</p>	<p><i>Breakfast</i> Cantaloupe & Honeydew Melon Lemon Poppyseed Muffin Fruited Yogurt Apple Juice Coffee</p>	<p><i>Breakfast</i> Morningstar Organic Breakfast Pattie & Cheese Biscuit Potatoes O'Brien Capri Sun – Tropical Fruit Coffee</p>
<p><i>Lunch</i> Mini Chef Salad with Dressing Morningstar Italian Sausage & Cheese Pizza Fruit Snack Diet Soda</p>	<p><i>Lunch</i> Cream of Broccoli Soup Red Pepper Hummus on Pretzel Crisps Fresh Apple Raisins Crystal Light</p>	<p><i>Lunch</i> Morningstar Sausage Crumbles & Cheese Enchilada Chips & Salsa Fresh Grapes Diet Soda</p>
<p><i>Snack</i> Yogurt Covered Raisins Crystal Light</p>	<p><i>Snack</i> Mr. Goodbar Diet Soda</p>	<p><i>Snack</i> Pretzels with Cheese Dip Crystal Light</p>
<p><i>Dinner</i> Lightlife “Steak Strips” Stroganoff Broccoli Spears Dinner Roll with Margarine Peach Crisp Ice Tea</p>	<p><i>Dinner</i> Boca Burger & Gravy Mashed Potatoes Green Beans Pineapple Upsidedown Cake Ice Tea</p>	<p><i>Dinner</i> Asian “Steak Strips” Stir fry Brown Rice Mandarin Oranges Gingersnaps Ice Tea</p>
<p><i>Snack</i> Pears with Cottage Cheese Water</p>	<p><i>Snack</i> Caramel Flavored Rice Cakes Diet Soda</p>	<p><i>Snack</i> Jell-O Chocolate Mousse Devil’s Food Cookie Water</p>

Soy & Legume – 20% Protein Menu

<i>Day 25</i>	<i>Day 26</i>	<i>Day 27</i>
<p><i>Breakfast</i> Tropical Fruit Salad Western Omelet with Cheese & Morningstar Sausage Crumbles Toast with Jam Capri Sun - Sunrise Coffee</p>	<p><i>Breakfast</i> Cantaloupe & Honeydew Melon Lemon Poppyseed Muffin Fruited Yogurt Light Orange Juice Coffee</p>	<p><i>Breakfast</i> Morningstar Organic Breakfast Pattie & Cheese Biscuit Potatoes O'Brien Capri Sun – Tropical Fruit Coffee</p>
<p><i>Lunch</i> Mini Chef Salad with Dressing Morningstar Italian Sausage, Mushroom & Cheese Pizza Fruit Snack Diet Soda</p>	<p><i>Lunch</i> Cream of Broccoli Soup Red Pepper Hummus on Flatbread Crisps Fresh Apple Crystal Light</p>	<p><i>Lunch</i> Morningstar Sausage Crumbles & Cheese Enchilada Chips & Salsa Fresh Grapes Diet Soda</p>
<p><i>Snack</i> Pretzels with Ranch Dip Crystal Light</p>	<p><i>Snack</i> Cinnamon Brown Sugar Almonds Diet Soda</p>	<p><i>Snack</i> Homemade Granola Crystal Light</p>
<p><i>Dinner</i> Lightlife “Steak Strips” Stroganoff Broccoli Spears Dinner Roll with Margarine Peach Crisp Ice Tea</p>	<p><i>Dinner</i> Boca Burger & Gravy Mashed Potatoes Green Beans Almondine Dinner Roll Pineapple Upsidedown Cake Ice Tea</p>	<p><i>Dinner</i> Asian “Steak Strips” Stir fry Soba Noodles Mandarin Oranges Gingersnaps Ice Tea</p>
<p><i>Snack</i> Pears with Cottage Cheese Water</p>	<p><i>Snack</i> Cheesy Herb Popcorn Diet Soda</p>	<p><i>Snack</i> Chocolate Mousse with Oreo Crumbs Water</p>

Soy & Legume – 30% Protein Menu

<i>Day 25</i>	<i>Day 26</i>	<i>Day 27</i>
<p><i>Breakfast</i> Tropical Fruit Salad Western Omelet with Cheese & Morningstar Sausage Crumbles Toast with Jam V8 Juice Coffee</p>	<p><i>Breakfast</i> Blackberries Lemon Poppyseed Muffin Fruited Yogurt with Wheat Germ Carrotty Orange Juice Coffee</p>	<p><i>Breakfast</i> Open Face Morningstar Organic Breakfast Pattie & Cheese Biscuit Potatoes O'Brien Naked Very Berry Juice Coffee</p>
<p><i>Lunch</i> Mini Chef Salad with Dressing Morningstar Italian Sausage, Mushroom & Cheese Pizza Sugar Free Gelatin Diet Soda</p>	<p><i>Lunch</i> Cream of Broccoli Soup Tofurky “Hickory Smoked Sandwich with Lettuce, Cheese, Tomato and Mustard Crystal Light</p>	<p><i>Lunch</i> Morningstar Sausage Crumbles & Cheese Enchilada Chips & Salsa Sugar Free Gelatin Diet Soda</p>
<p><i>Snack</i> Pretzels with Ranch Dip Crystal Light</p>	<p><i>Snack</i> Cheesy Herb Popcorn Diet Soda</p>	<p><i>Snack</i> Homemade Granola Crystal Light</p>
<p><i>Dinner</i> Lightlife “Steak Strips” Stroganoff Asparagus Spears Whole Wheat Bread with Margarine Peach Crisp Ice Tea</p>	<p><i>Dinner</i> Boca Burger & Gravy Mashed Potatoes Green Beans Almondine Whole Wheat Bread Pineapple Chunks Ice Tea</p>	<p><i>Dinner</i> Asian “Steak Strips” Stir fry Soba Noodles Mandarin Oranges Ice Tea</p>
<p><i>Snack</i> Pears with Cottage Cheese Water</p>	<p><i>Snack</i> Frozen Smoothie Diet Soda</p>	<p><i>Snack</i> Chocolate Mousse Water</p>

Appendix 3: Test Day Menu – All Subjects

Breakfast

(25% Energy, 10/20/30% Protein)

Fresh Red Grapes

English M^cCampbell

(English Muffin, American Cheese, Beef Tenderloin and Canadian Bacon/Soy Breakfast Pattie)

Margarine

Welch's 100% Apple White Grape Juice Box

Water

Lunch

(40% Energy/15% Protein)

Grilled Beef Tenderloin with Béarnaise Sauce

Seasoned Brown and White Rice

Sautéed Whole Wax & Green Beans

Fresh Yeast Roll with Margarine

Make Your Own S'More

Ice Tea

Dinner

(25% Energy/15% Protein)

Caesar Salad

Cheese Ravioli with Marinara Sauce

Crusty Italian Roll

Vanilla Pizzelle Cookie

Light Cherry Limeade

HS Snack

(10% Energy/15% Protein)

Chocolate Éclair

Skim Milk