

## HUMAN NUTRITION

**Title:** Increased protein intakes from predominantly meat- versus soy protein/pulses-based foods: Effects on daily and postprandial appetite during energy restriction-induced weight loss – **NPB #09-155**

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

This project is co-sponsored by the National Cattlemen's Beef Association

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### 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 legumes 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 legumes 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 legumes. Higher protein intake from both lean beef and pork or soy and legumes promoted decreased hunger and desire to eat and greater fullness 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. 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](mailto:campbellw@purdue.edu).

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**Keywords:** Protein, Plasma Amino Acids, Satiety, Appetite, Thermogenesis, Weight Loss, Hunger, Mood

**Scientific Abstract:** (The following two abstracts were presented as posters at Experimental Biology, 4/12. In addition, the first abstract was also an oral presentation at Experimental Biology, 4/12)

### **The effects of quantity and source of dietary protein on appetite and plasma amino acid concentration**

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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 (AMDR) and are predominantly from meat vs. plant sources. Thirty-four overweight/obese subjects ( $53 \pm 12$  y, BMI  $30.8 \pm 2.6$  kg/m<sup>2</sup> mean  $\pm$  SD) were randomly assigned to consume diets with 750 kcal/d below energy need and beef/pork (5M:12F) or soy/legumes (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, fullness and desire to eat before and 15, 25, 60, 85, 120, 180 and 240 min after eating. AAs were measured in 5 subjects each from the two P source groups before and 25, 60, 120, 180 and 240 min after eating. PP hunger and desire to eat (weighted averages) was lower and fullness (weighted average) was higher than fasting for all P quantities ( $p < 0.01$ ). In AA subset, PP fullness was higher (weighted average) than fasting for all P quantities ( $p < 0.05$ ). Protein source did not affect appetitive responses. Postprandial (PP) branched chain AA and leucine (weighted averages) were higher for beef/pork vs. soy/legumes ( $p < 0.05$ ) and were progressively higher with increasing P intake ( $p < 0.05$ ). PP total AA were higher for 30 vs. 20 and 10% ( $p < 0.01$ ). PP appetitive responses (weighted average) were not related to PP AA responses ( $\Delta$  weighted average). Higher protein intake from meat or plant sources promotes reduced desire to eat, unrelated to differential plasma amino acid responses to feeding.

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

### **Effect of Protein Source (Animal Versus Vegetable) and Quantity on Indices of Mood, Tryptophan and Large Neutral Amino Acids**

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The balance between plasma tryptophan (Trp) and other large neutral amino acids (LNAA) from dietary protein (P) influences serotonin synthesis which may impact indices of mood. This study was designed to assess effects of P quantity and source on fed-state (FS) LNAA and Trp and mood. 34 overweight/ obese adults ( $53 \pm 12$  y, BMI  $30.8 \pm 2.6$  kg/m<sup>2</sup>, mean  $\pm$  SD) were randomly assigned to consume diets with 750 kcal/d below energy need and 10, 20 or 30% energy from P with beef/pork (5M:12F) or soy/legumes (6M:11F) as the predominate P source for 3 randomized 28d trials. On day 28, subjects consumed a trial-specific test meal and completed the Profile of Mood Survey (POMS) before and 15, 25, 60, 85, 120, 180 and 240 min after eating. Fasting and FS LNAA and Trp were measured in 5 subjects each from the two P source groups before and 25, 60, 120, 180 and 240 min after eating. FS LNAA (weighted averages) was higher for beef/pork vs soy/legumes ( $p < 0.05$ ), and progressively higher with increasing P intake ( $p < 0.01$ ). Independent of source, FS Trp was greater ( $p < 0.01$ ) and Trp:LNAA was lower ( $p < 0.05$ ), for 30 vs. 20 and 10% P. FS total AA were higher for 30

vs. 20 and 10% ( $p < 0.01$ ). Protein quantity and source did not affect total mood disturbance or the six POMS subcategories (vigor, fatigue, depression, confusion, tension, anger). While protein intakes predominately from meat or plant sources that span the acceptable macronutrient distribution range affect plasma LNAA and Trp, they do not acutely impact mood.

*Support: The Beef Checkoff, National Pork Board, NIH RR025761*

### **Introduction from original proposal:**

Dietary protein is generally recognized as the most satiating macronutrient (1). Higher protein intake is documented to reduce energy intake at the next meal (2) and is often promoted to increase satiety during periods of energy restriction-induced weight loss (1, 3). However, the vast majority of higher protein studies were acute/short-term assessments (1-24 hours) conducted in normal-weight subjects who were tested without regard to body weight control and/or habitual dietary protein intake, and did not systematically compare protein sources (esp. meat vs. soy/legumes) (2). Postprandial (i.e. post-meal) plasma amino acid profiles are also rarely assessed, but potentially important (4, 5). Recent critical reviews of the protein and appetite literature (3, 6) strongly support the need for highly controlled, medium-term (2 to 3-week) studies to investigate the effects of habitual dietary protein intake (from different sources) on chronic (i.e. daily) satiety and acute (i.e. postprandial) satiety, energy expenditure, appetite-related hormones (e.g., insulin, glucose, peptide YY (PYY), glucagon-like peptide 1 (GLP-1), cholecystokinin (CCK), and ghrelin), and plasma amino acids response during energy restriction-induced weight loss.

Although protein is generally agreed to be the most satiating macronutrient, limited data exist regarding which protein source (e.g. meat, soy, whey, casein, etc.) is the most satiating (3, 7). Long-term studies (8, 9) investigating weight-loss differences (but not satiety) between casein, whey and/or soy using liquid supplementation are the most common and suggest that soy protein is just as good as other protein sources for weight loss (10). We identified only one longer-term (16-wk) study (11), using a mixed-meal approach (11.5% energy from meat protein or 3.5% energy from meat/7.5% energy from soy); the authors reported no differences in weight loss between the meat and soy groups; satiety was not measured. Results from short-term (1-24 hours) studies assessing energy intake, satiety, and appetite-related hormones from different protein sources are mixed (see table below), and potentially hampered by differences in study protocols, different protein sources (meat sources typically not included) and form of protein (i.e. beverage, single food, pasta, soup, mixed meal) tested.

Only one study (12), using a mixed meal approach, was identified comparing soy with meat (i.e. primarily pork) and reported that pork-meat resulted in a 2% higher 24-hr energy expenditure than a soy diet; satiety, although apparently measured, was not reported.

The very limited published information and paucity of data from direct comparisons between meat (beef/pork) and soy/legumes underscore the need for the proposed research, yet contributes to the challenge of formulating hypotheses and estimating sample size. Our research group has considerable experience conducting highly controlled, medium-term studies investigating appetitive, thermogenic and hormonal response during energy-restriction weight loss, including assessments of the daily appetitive responses to habitual lacto-ovo-vegetarian protein diets at the lower range of adequacy (13); habitual (12-week) consumption of higher-protein, pork-based energy restriction diets with protein intakes at the higher end of the acceptable macronutrient distribution range (AMDR) (14, 15); and the effects of higher-protein, pork-containing breakfasts on acute appetitive responses (16). Collectively, these results support the need to systematically assess chronic appetitive and acute

appetitive, thermogenic, and glycemic responses to protein intakes across the AMDR (Study Aims 1 and 2; primary objectives) and to explore potential differential responses between meats and soy/legumes (Study Aims 1 and 2; secondary objectives).

<b>Protein Sources</b>	<b>Participants</b>	<b>Experimental Design</b>	<b>Results</b>	<b>Ref.</b>
Soy Casein Whey	n = 11 males 14 females  <b>BMI:</b> 23.9±0.3	<b>Length:</b> 4 h repeated measures (1 wk between sessions) <b>Diet:</b> Standardized breakfasts (~600 kcal custards 10% or 25% energy from test protein), ad lib lunch (3-4 h after breakfast)	<b>Energy Intake</b> -- at 10 & 25% - NS <b>Satiety</b> -- at 10% - Hunger ↓ 30% after whey than casein, -- at 25% - NS <b>Glycemic Response</b> -- at 10% - insulin ↑ 30% after casein than soy -- at 25% - glucose ↑ 80% after soy than casein and insulin ↑ 57% after soy and 91% after whey than casein	(17)
Minced Fish Minced Beef	n = 23 males  <b>BMI:</b> 22.5±1.8	<b>Length:</b> 4 h repeated measures (1 wk between sessions) <b>Diet:</b> Standardized breakfast, lunch ~600 kcal lunch 45% energy from protein (42.5% from beef or fish) , ad lib dinner 4 h later	<b>24-hr intake</b> – NS <b>Dinner intake</b> – Fish ↓ intake ~75 kcal <b>Satiety</b> – NS <b>Glycemic Response</b> – NA	(18)
Soy Whey Wheat Gluten Glucose	n = 72 men  <b>BMI:</b> 20-40	<b>Length:</b> 4 h repeated measures (1 wk between sessions) <b>Diet:</b> Standardized evening meal, breakfast ~300 kcal beef-flavored soups 71% energy from protein (1% in glucose soup), ad lib lunch 4 h later	<b>Energy intake</b> – 10% lower for all protein preloads compared to glucose <b>Satiety</b> – NS <b>Glycemic Response</b> – ↑ after glucose soup	(19)
Mycoprotein Tofu Chicken	n = 42 females  <b>BMI:</b> 25-30	<b>Length:</b> 9 h repeated measures (1 day between sessions) <b>Diet:</b> Standardized breakfast, ~450 kcal pasta lunch 16-17% protein (5% from mycoprotein/ chicken and 2% from tofu) + ad lib ham sandwiches 20 min and dinner 4 h later	<b>20-min intake</b> – ↓38-45 kcal with mycoprotein and tofu <b>4-h intake</b> - NS <b>Satiety</b> – NS <b>Glycemic Response</b> - NA	(20)
Soy Egg Albumin Whey Sucrose Water (control)	n = 13 males  <b>BMI:</b> ~21-23	<b>Length:</b> 1-2 h, repeated measures <b>Diet:</b> Sweetened beverage preload with 45-50 gm protein, ad lib pizza meal 1-2 h later	<b>Energy intake</b> – Whey ↓ energy more than other proteins <b>Satiety</b> – NA <b>Glycemic Response</b> – NA	(7)
Soy Pork Carbohydrate	n = 12 males  <b>BMI:</b> 28.9±1.7	<b>Length:</b> 4 d, repeated measures (1-10 wk washout period between) <b>Diet:</b> Iso-energetic with 29% energy from protein (17-18% from soy or pork) or 11% energy from protein (0% soy & pork)	<b>24-h Energy Expenditure</b> – Pork 1.9% > Soy, Pork 3.9% > Carb., Soy 1.9% > Carb. <b>Satiety</b> – Measured but not reported <b>Glycemic Response</b> - NA	(12)
Soy Gelatin Casein	n = 9 males  <b>BMI:</b> 22.9±0.7	<b>Length:</b> 24 h repeated measures (1 wk between sessions) <b>Diet:</b> Standardized breakfast, ~425 & 850 kcal mixed meal lunch, ~15% energy from test proteins, ad lib dinner buffet (8 h after lunch)	<b>24-h intake</b> – NS <b>Satiety</b> – NS <b>Glycemic Response</b> - Casein (vs. soy) delayed 1.5 hrs	(21)
Egg Albumin Casein Gelatin (pig) Soy Protein Pea Protein Wheat Gluten	n = 12 males  <b>BMI:</b> 21.9±0.5	<b>Length:</b> 8 h repeated measures (1 wk between sessions) <b>Diet:</b> Standardized breakfast, ~1200 kcal mixed meal lunch ~15% energy from test proteins, ad lib dinner buffet (8 h after lunch)	<b>24-h intake</b> – NS <b>Satiety</b> – NS <b>Glycemic Response</b> - NS	(21)
Lean fish Lean beef Lean chicken	n = 6 males  <b>BMI:</b> 21.7±0.7	<b>Length:</b> 3 h repeated measures (1 wk between sessions) <b>Diet:</b> Grilled 50 gm protein (topside steak, skinless chicken breast, or fish)	<b>24-h intake</b> – NA <b>Satiety</b> – greater after fish meal <b>Glycemic Response</b> – Insulin ↑ after all meals	(5)

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 (22). Similar results were also observed following consumption of a breakfast containing 25 vs. 10% energy from soy protein (23). These observations are supported by Mellinkoff et al. “aminostatic” theory, which states that increased protein consumption results in increased plasma amino acid concentrations (24). Differences in the tertiary structure of individual amino acids may affect their behavior in the gastrointestinal tract and therefore their effectiveness,

or quality (25). 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 (26). 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 (26) which is especially thermogenic (27) and stimulates muscle protein synthesis (28). Given the strong positive correlation between thermogenesis and satiety (29), a reported association between plasma amino acid concentration and satiety (22, 23), and the absence of studies investigating the effect of red meat consumption, a systematical assessment of postprandial plasma amino acid concentrations across the AMDR (Study Aim 2; primary objective), exploration of differential responses between beef/pork and soy/legumes (Study Aim 2; secondary objective), and exploration of the relationship between postprandial plasma amino acid concentrations and satiety (Study Aim 3; primary objective) and differential responses between beef/pork and soy/legumes (Study Aim 3; secondary objective) is warranted.

### **Stated Objectives from original proposal:**

The objectives of this research project (original and addendum) were to assess the effects of habitual dietary protein intakes across the AMDR (10%, 20%, or 30% of energy), with lean beef/pork or soy/legumes as the predominant sources of protein, on daily appetitive and postprandial appetitive, thermogenic, glycemic, and plasma amino acid responses during weight loss in overweight adults.

#### **Specific Aims:**

**Aim 1:** Assess the effects of habitual protein intake from lean beef/pork or soy/legumes sources across the AMDR (10%, 20%, or 30% of energy) on indices of daily appetite (e.g. hunger, desire to eat, and fullness).

#### **Hypotheses:**

**Primary:** Increasing protein intake from lean beef/pork or soy/legumes sources across the AMDR will result in progressively decreased daily composite hunger and desire to eat, and increased fullness (increased chronic satiety).

**Secondary:** The differential appetitive responses will not be different between the beef/pork and soy/legumes groups of subjects.

**Aim 2:** Assess the effects of the quantity (10%, 20%, and 30% of energy) of protein from lean beef/pork or soy/legumes sources on postprandial appetite, energy expenditure, glycemic (plasma glucose and insulin) response, and plasma amino acid concentrations.

#### **Hypotheses:**

**Primary:** Increasing the protein content of a test meal (from higher beef/pork or soy/legumes intake) will result in progressively more robust and sustained changes in postprandial appetite (decreased hunger/desire to eat and increased fullness), energy expenditure (increased thermogenesis), glycemic response (blunted), and plasma amino acid concentrations (increased total, branched chain amino acids and leucine).

**Secondary:** The differential responses will not be different between the beef/pork and soy/legumes groups of subjects.

**Aim 3:** Assess the relationship of the quantity (10%, 20%, and 30% of energy) of protein from lean beef/pork or soy/legumes sources between postprandial plasma amino acids and appetite (hunger, desire to eat, and fullness).

**Hypotheses:**

**Primary:** Postprandial plasma amino acid concentrations will be correlated with postprandial appetite responses (decreased hunger/desire to eat and increased fullness).

**Secondary:** The differential responses will not be different between the beef/pork and soy/legumes groups of subjects.

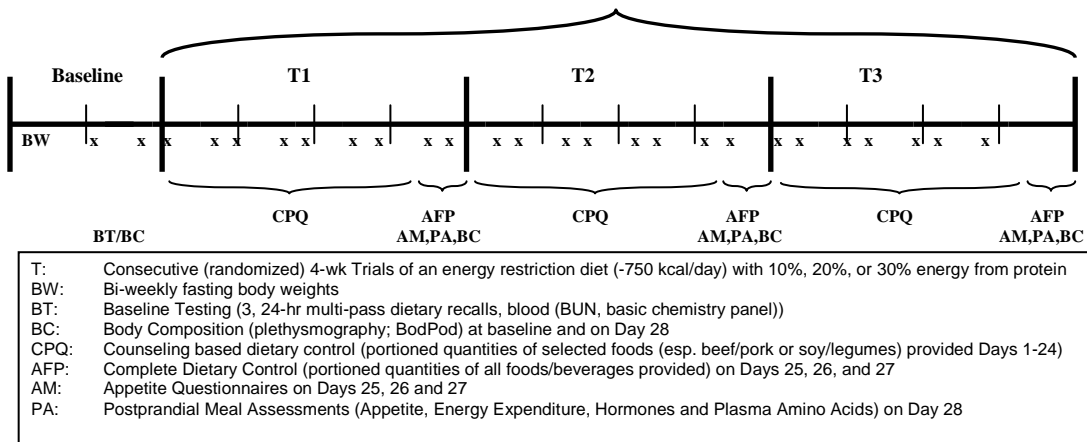
**Materials & Methods:**

**Subjects and Recruitment:** Men and women (age 21y or older, body mass index 27-37 kg/m<sup>2</sup>; 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. Funding, wholly or in part, was provided by The National Pork Board, The Beef Checkoff, and NIH RR025761.

**Experimental Design:** Subjects were randomly assigned to either the lean beef/pork or soy/legumes 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/legumes 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/Legumes



Each subject's energy requirements were estimated using the sex-specific equation published by the Institute of Medicine (30). Subjects consumed an energy restriction diet (-750 kcal/day) containing 25% fat, 10%, 20%, or 30% protein (with lean beef/pork or soy/legumes whole food products as the predominant protein sources) and 65%, 55%, or 45% carbohydrate. The 10%, 20%, and 30% energy from protein intake was chosen because it spans the acceptable macronutrient distribution range for protein [note the AMDR for protein is 10-35% of energy intake during weight maintenance (31), but very few people habitually consume protein intakes at the upper limit of the range (31,32)]. The sources of protein followed those typically consumed by adults (31), including ~30% lean beef/pork or soy/legumes, ~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/legumes) and were counseled to follow a prescribed menu of specific foods and beverages to achieve the desired macronutrient and energy intakes (See Appendix 1 for sample menus). 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 (other than water) (See Appendix 2 for sample menus). 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, 15,16) and a measure of dietary compliance.

**Postprandial Meal Assessment:** 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 below for more detail). After voiding, subjects were weighed, urine collection



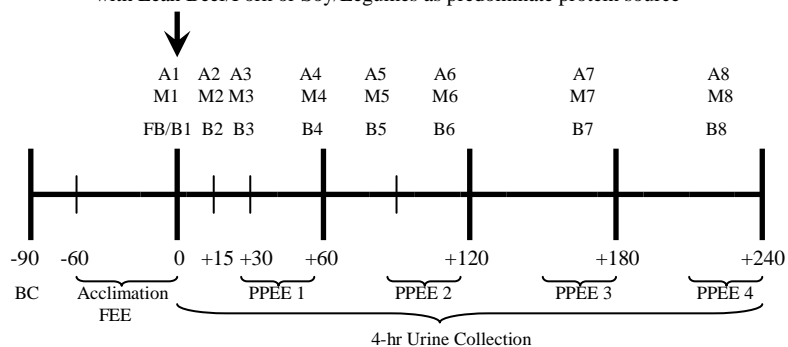
began, blood pressure and appetite were measured, and fasting blood was drawn. After resting energy expenditure testing, subjects consumed a test meal providing 25% of their daily energy need and protein content/source of the diet they were consuming at the time of testing. The test meal (Figure 1) consisted of portioned quantities of a breakfast sandwich containing English muffin, meat (lean beef and pork or meatless sausage pattie) 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 and post-meal energy expenditure was measured 30, 90, 150, and 210 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/legumes 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.



### Postprandial Assessments - Day 28 of each 4-week Trial

**Acute Test Meal Administered** (25% Total Daily Energy Restriction Diet)  
with Lean Beef/Pork or Soy/Legumes as predominate protein source



BC:	Body Composition (plethysmography; BodPod)
A:	Appetite Questionnaires (visual analog scale)
M:	Mood Questionnaires (Profiles in Mood State)
FB:	Fasting Blood Sample (blood urea nitrogen and basic chemistry panel)
B:	Blood – serum insulin, serum glucose and plasma amino acids
FEE:	Fasting Energy Expenditure
PPEE:	Postprandial Energy Expenditure

### Measurements:

Clinical Health Assessments: Fasting-state blood samples were collected at baseline and prior to postprandial testing (Day 28 of each 4-week trial). Serum was extracted and analyzed for glucose, insulin, BUN, creatinine, electrolytes, and lipid-lipoprotein profile. Blood pressures, in

duplicate, were measured using a sphygmomanometer. 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 a subsample of subjects (5 beef and pork and 5 soy and legume) were quantified by cation-exchange chromatography (cIEC-HPLC) coupled with post-column ninhydrin derivatization and quantitation (33) by the Agricultural Experimental Station Chemical Laboratories University of Missouri-Columbus.

**Body Composition:** Fasting-state body mass (total mass – robe mass) was measured using a digital platform scale (model ES200L, Ohaus Corporation, Pine Brook, NJ) and standing height without shoes was measured during baseline with a wall-mounted stadiometer. At baseline and on Day 28 of each 4-week trial, waist and hip circumference was measured and body composition was determined using a plethysmography system (BodPod, Life Measurements, Concord, CA). Each subject's fasting-state body weight was also measured twice weekly to document the effectiveness of the energy-restriction diet.

**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” (34). The questionnaire was completed on Days 25-27 of each 4-week trial upon awakening and at 60-minute intervals until bedtime, and during postprandial meal testing on Day 28 prior to and 15, 25, 60, 85, 120, 180, and 240 minutes post-meal.

**Energy Expenditure:** Fasting energy expenditure (FEE) and postprandial energy expenditure (PPEE) were measured using the indirect calorimetry method (MedGraphics Cardiopulmonary Diagnostics Systems; Medgraphics Corporation, St. Paul, MN). FEE measurement was taken after the subjects' arrival to the testing facility and a 30 minute rest and acclimation period in the reclining position. FEE was measured for a 30 minute period and PPEE was measured at minutes 30-60, 90-120, 150-180, and 210-240. The Weir Equation was used to estimate energy expenditure.

**Mood Assessment:** Subjects rated mood using an abbreviated version of the Profile of Mood States (35). This survey consists of 37 5-point Likert questions (1 = not at all and 5= extremely) and measures total mood disturbance and six subcategories: vigor, fatigue, depression, confusion, tension, and anger. Maximum scores are as follows: total mood 155, confusion 25, anger 35, depression 40, tension 30, fatigue 25, and vigor -30. The questionnaire was completed every waking hour during Day 25, 26, and 27 and 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/legumes; between-subject effect) and their interactions on the primary dependent variables (daily appetite, postprandial appetite, energy expenditure, glycemic response, and plasma amino acids) was determined using repeated measures ANOVA. Post hoc analyses will be conducted using the LSD method when a significant omnibus F-test is established from the repeated measures ANOVA. Pearson Correlations were used to determine the relationship between postprandial plasma amino acid concentrations and appetite. All statistical analyses will be 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 due to various reasons including relocation, financial issues and dietary non-compliance. There were no significant differences in baseline (Week 2) subject characteristics between groups (see Table 1).

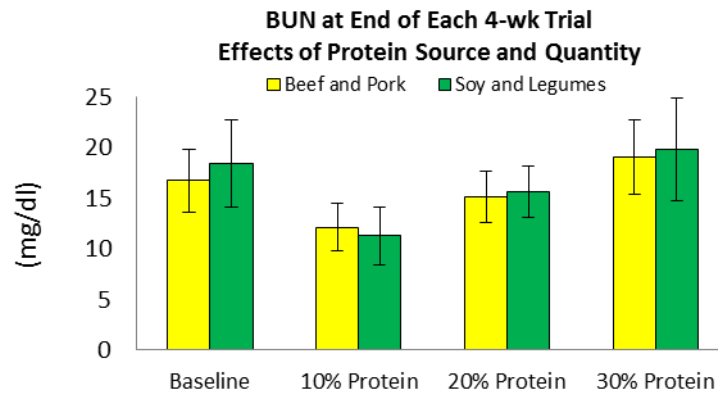
**Table 1:** Baseline Subject Characteristics

	<b>Total (n=34)</b>	<b>Beef and Pork (n=17)</b>	<b>Soy and Legumes (n=17)</b>
<b>Sex</b>	11 Males 23 Females	5 Males 12 Females	6 Males 11 Females
<b>Age (y)</b>	53.4 ± 12.4 Range (23-75)	51.2 ± 9.8 Range (30-66)	55.7 ± 14.5 Range (23-75)
<b>Weight (kg)</b>	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)
<b>BMI (kg/m<sup>2</sup>)</b>	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)
<b>Energy Restriction Diet Prescription * (kcal/day)</b>	1743.4 ± 331.6 (Range 1200-2400)	1746.5 ± 342.1 (Range 1200-2400)	1740.2 ± 331.2 (Range 1200-2400)
<b>Fasting Serum Glucose (mg/dl)</b>	87.6 ± 9.7 Range (50-107)	86.2 ± 11.4 Range (50-105)	89.1 ± 7.7 Range (77-107)
<b>Fasting Serum Insulin (µU/dl)</b>	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)
<b>Fasting BUN (mg/dl)</b>	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.

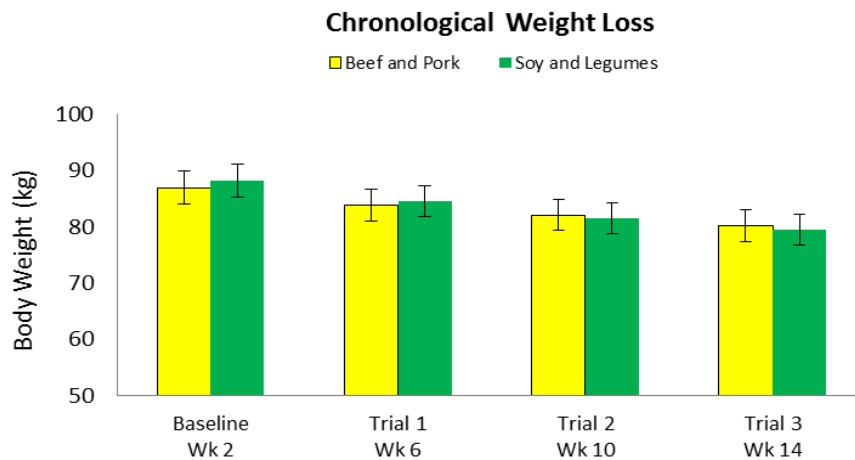
**Figure 2:** Fasting BUN at baseline (week 2) and after chronic feeding of each protein quantity for 4 weeks.



\*  $p < 0.001$  main effect of protein quantity

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 Legumes 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.

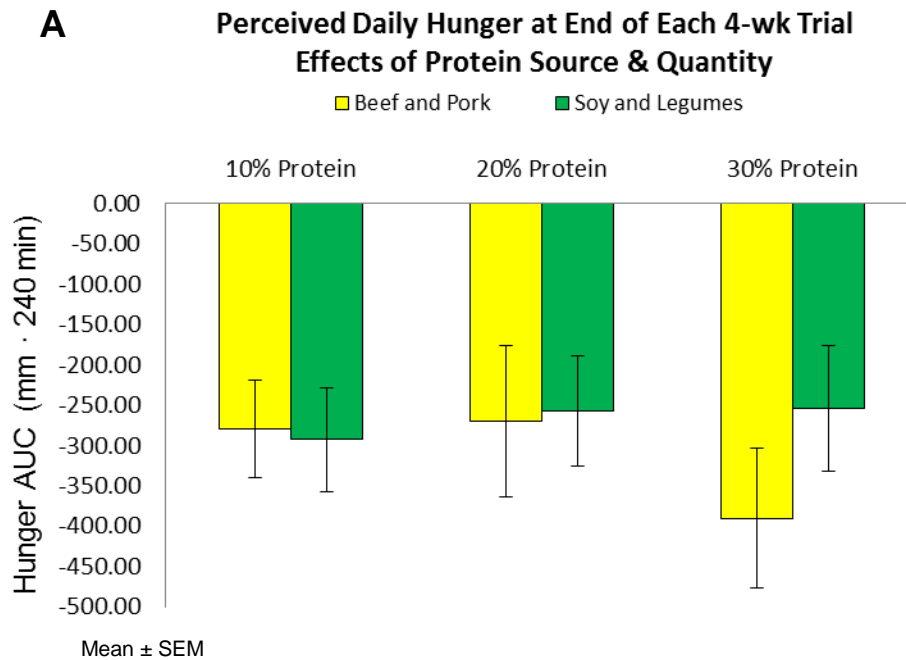
**Table 2:** Changes in Body Composition During Each 4-wk Trial

	<b>Group</b>	<b>10% Protein</b>	<b>20% Protein</b>	<b>30% Protein</b>
<b>Weight (kg)</b>	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
<b>Fat Mass (kg)</b>	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
<b>Lean Mass (kg)</b>	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
<b>% Fat Mass</b>	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
<b>Fat Mass Index (FM(kg)/Ht(m<sup>2</sup>))</b>	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
<b>Lean Mass Index (LM(kg)/Ht(m<sup>2</sup>))</b>	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 Habitual Protein on Indices of Daily Appetite:**

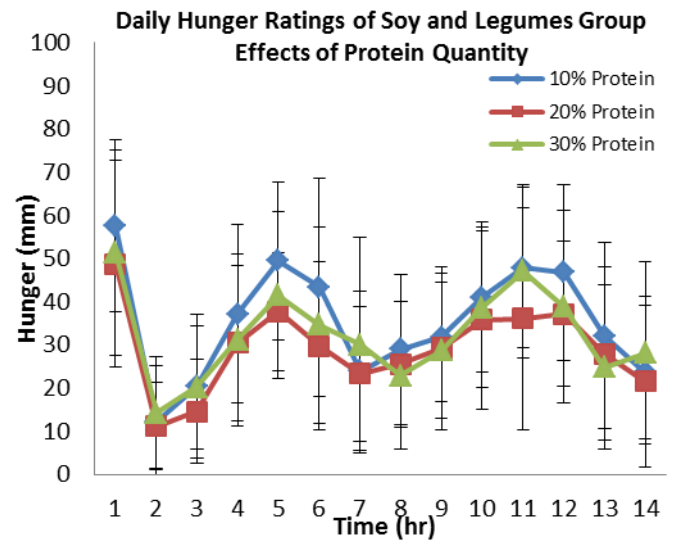
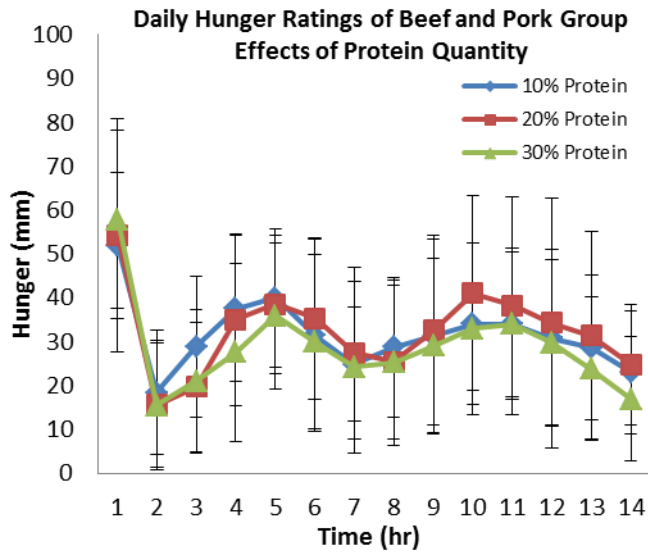
Daily hunger (Figure 4), desire to eat (Figure 5), and fullness (Figure 6) were not significantly influenced by the quantity or predominant source of protein.

**Figure 4:** Daily hunger area under the curve (A) and mean response (B and C) by predominate protein source and quantity.

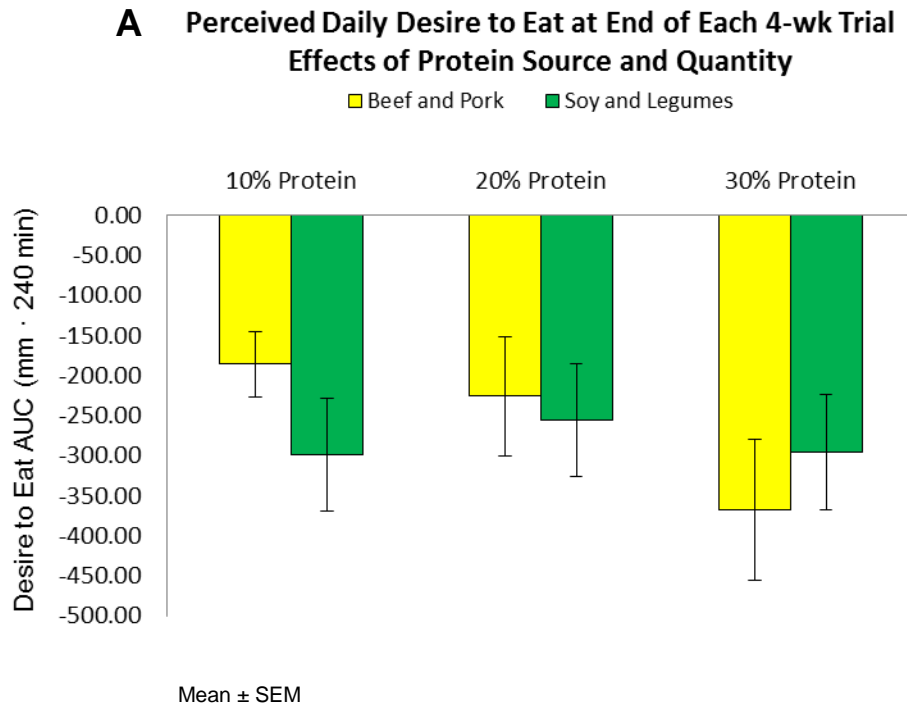


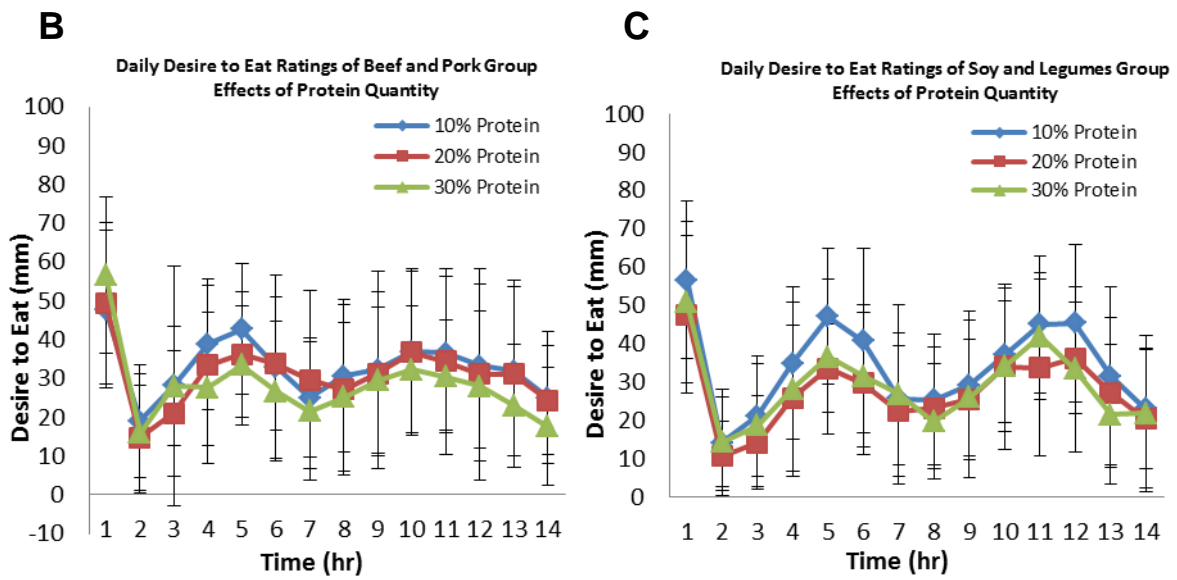
**B**

**C**

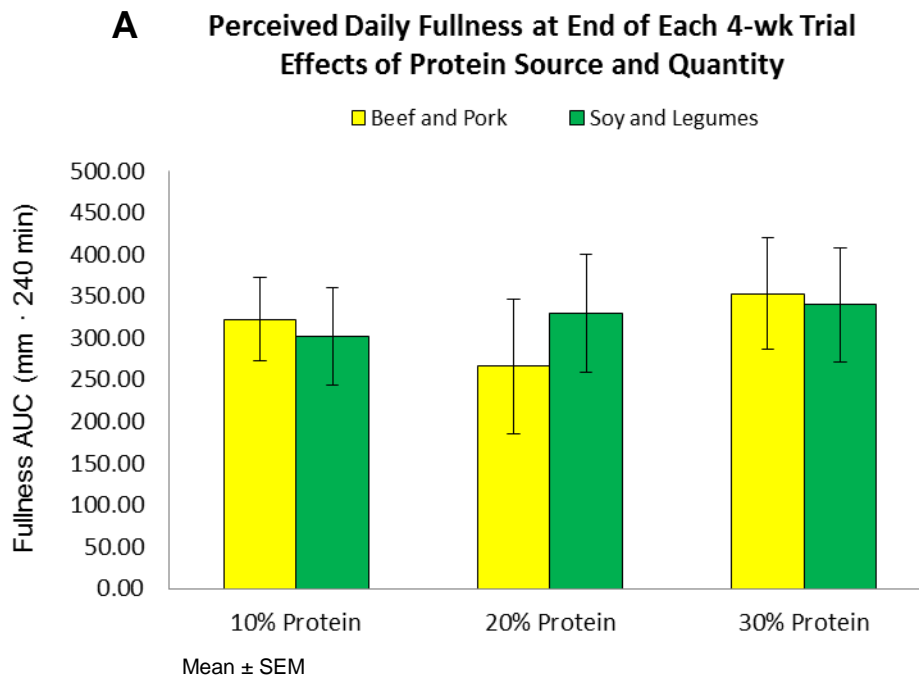


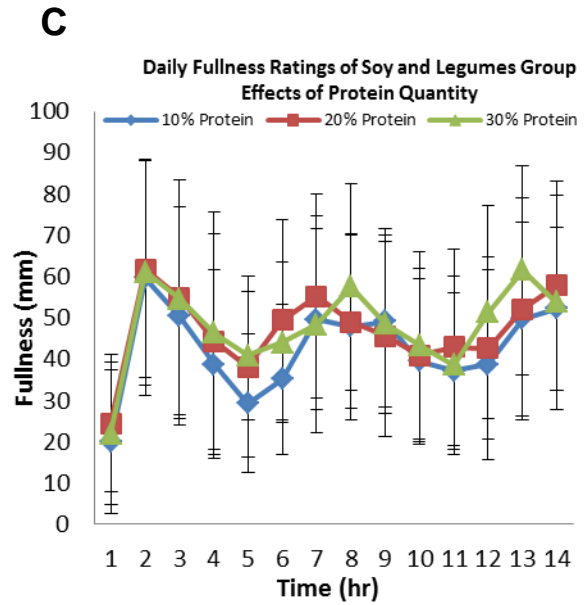
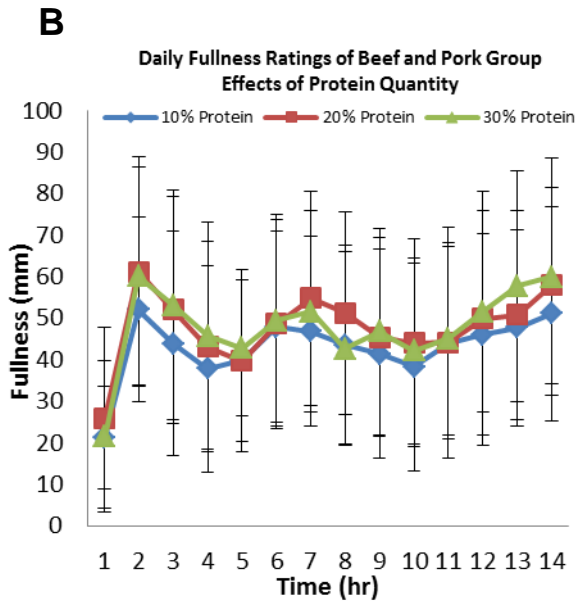
**Figure 5:** Daily desire to eat area under the curve (A) and mean response (B and C) by predominate protein source and quantity.





**Figure 6:** Daily fullness area under the curve (A) and mean response (B and C) by predominate protein source and quantity.





### Effects of the Protein Quantity on Postprandial Plasma Amino Acid Concentrations, Appetite, Energy Expenditure, Glycemic Response, and Mood

#### Plasma Amino Acids:

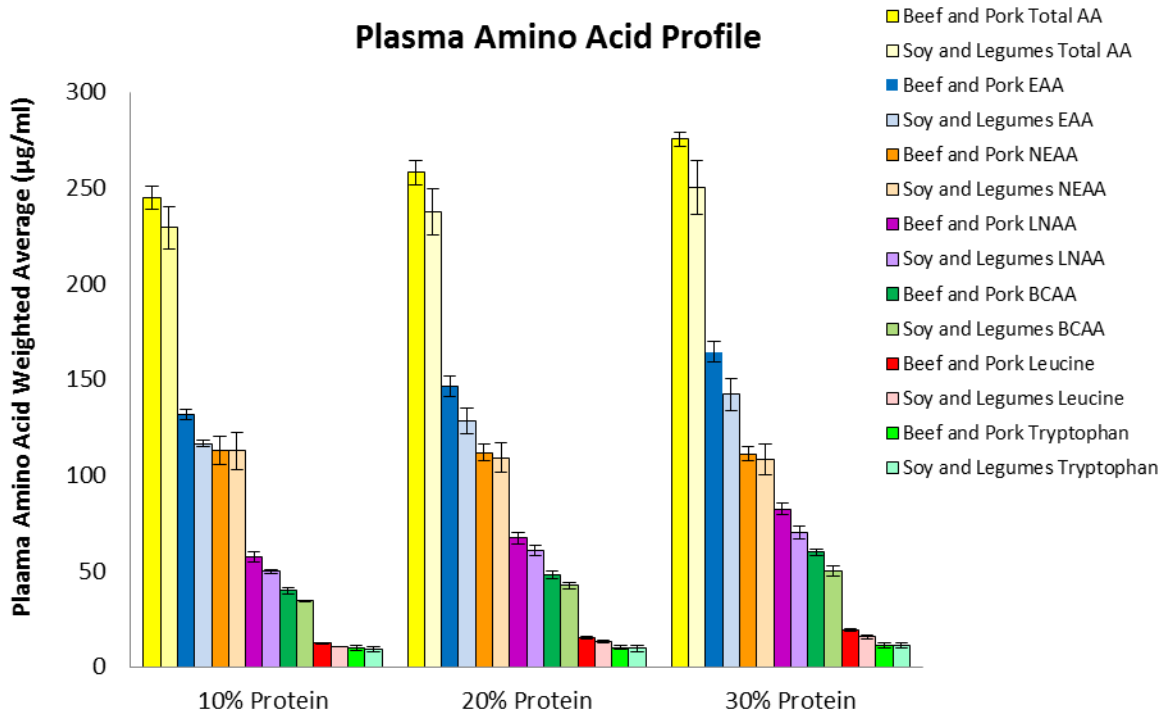
Ten individuals (1 male; 9 females), matched according to their test specific energy requirements, had their plasma amino acid profile quantified (see Figure 7). There were no significant differences in baseline subject characteristics between groups (see Table 3).

**Table 3:** Baseline Subject Characteristics of Amino Acid Subset

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



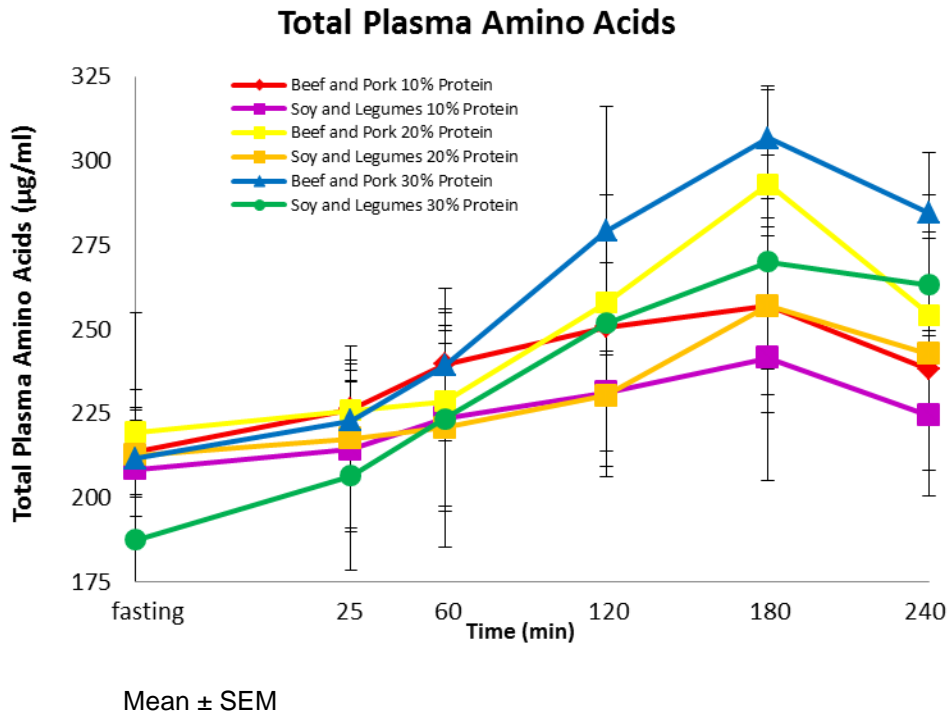
**Figure 7: Plasma amino acid profiles (weighted averages)**



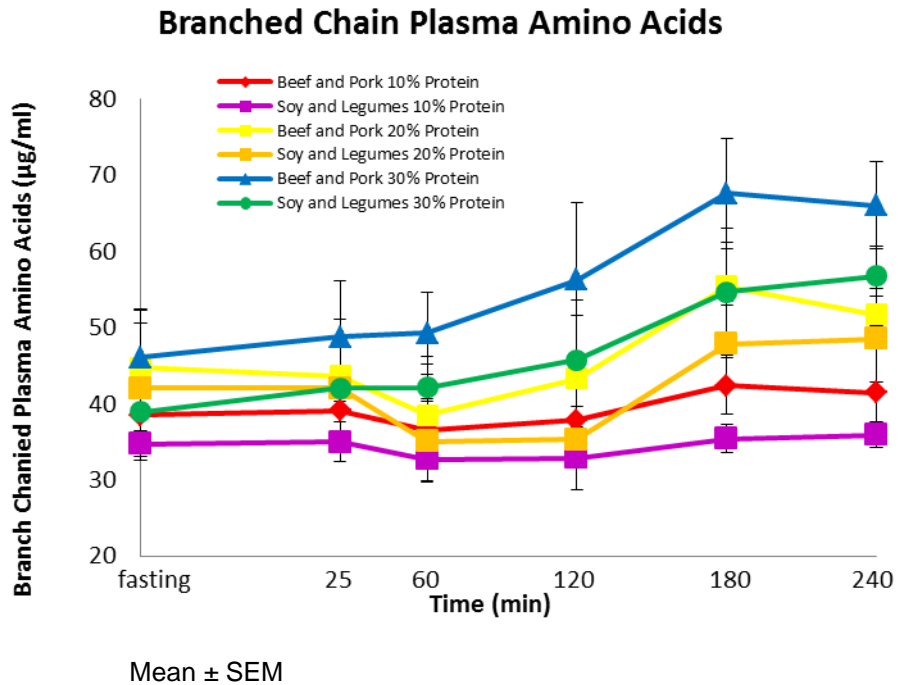
Mean ± SEM

Postprandial branched chain (Figure 9), essential (Figure 10) large neutral amino acids (Figure 11) and leucine (Figure 12) 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 8) and tryptophan (Figure 13) were higher at 30% vs. 20 and 10% protein ( $p < 0.01$ ), and tryptophan:large neutral amino acids ratio (Figure 14) 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 15).

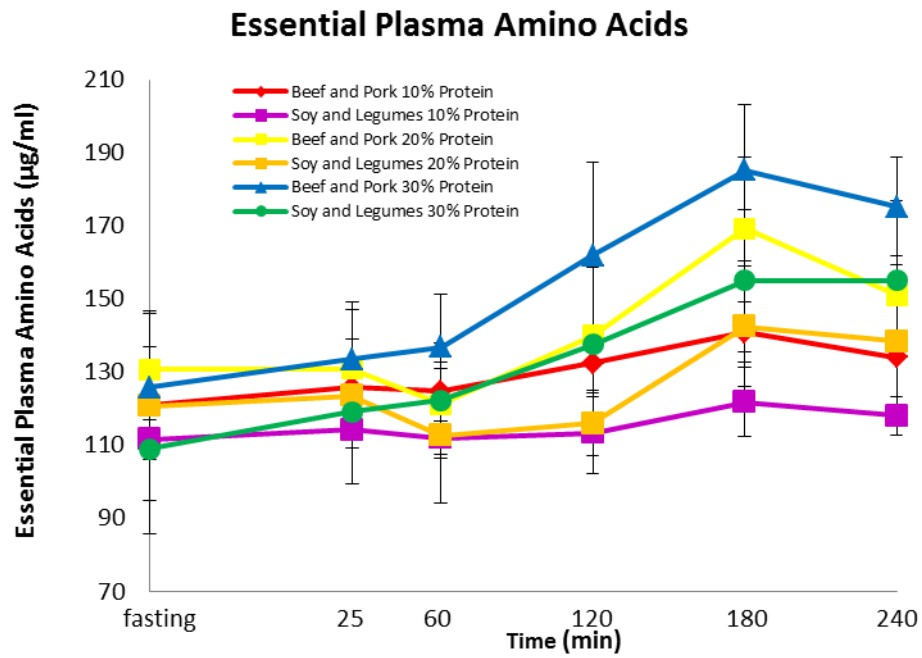
**Figure 8:** Total plasma amino acids by predominate protein source and quantity.



**Figure 9:** Branched chain amino acid by predominate protein source and quantity.

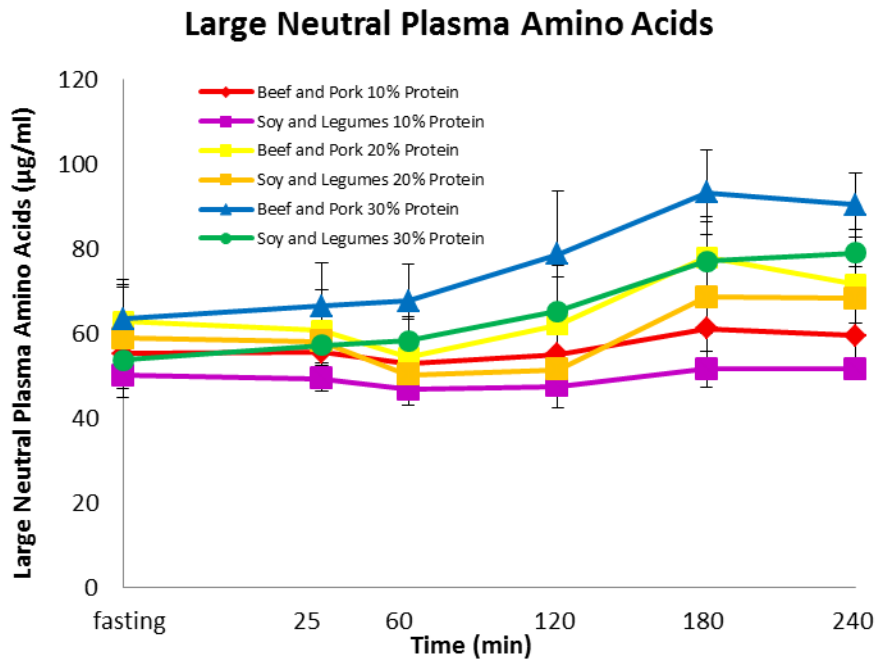


**Figure 10:** Essential amino acid by predominate protein source and quantity.



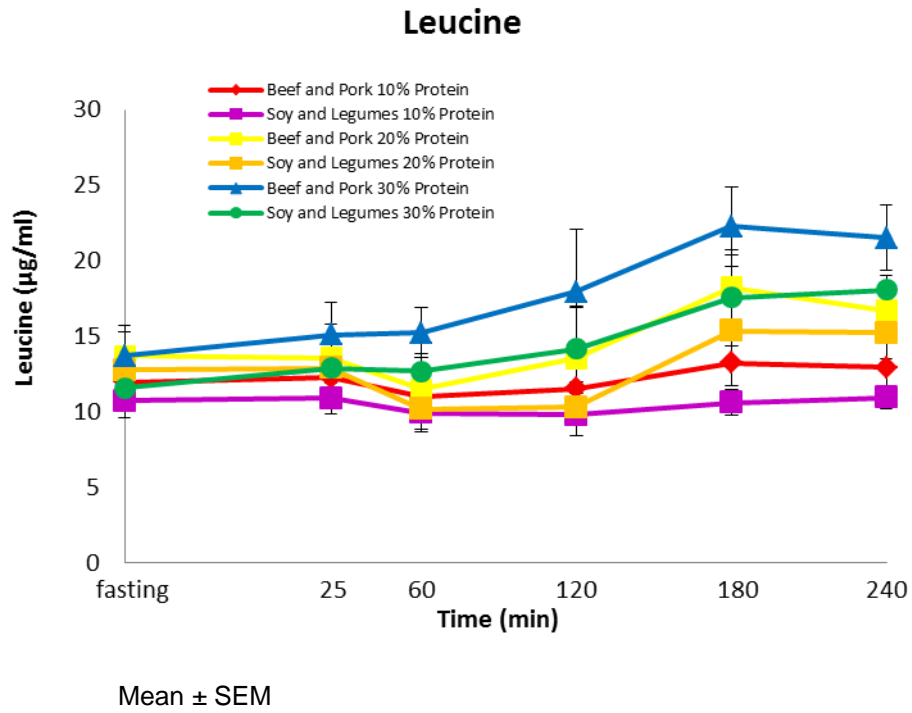
Mean ± SEM

**Figure 11:** Large neutral amino acid by predominate protein source and quantity.

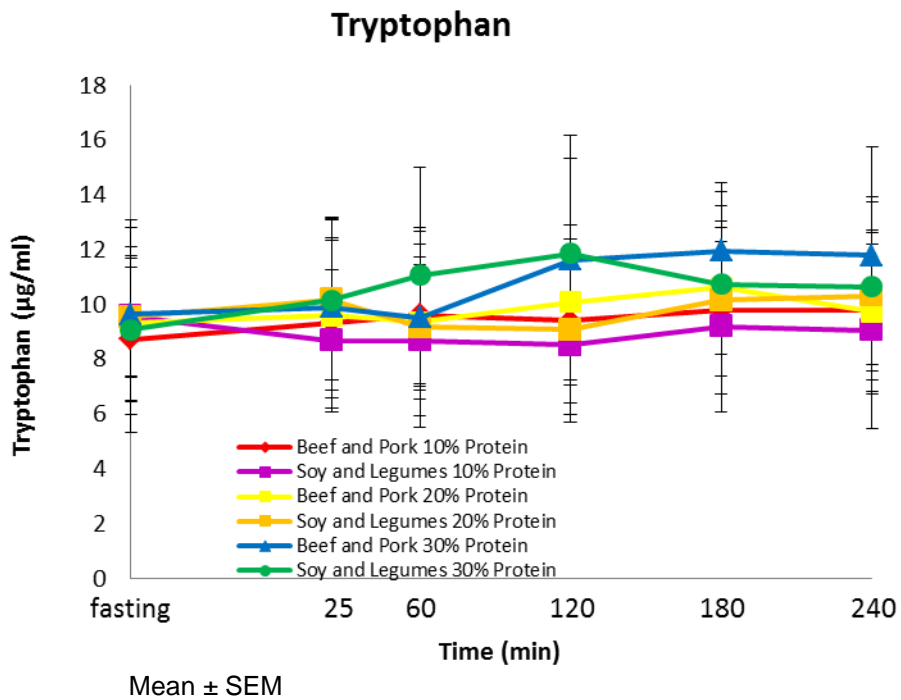


Mean ± SEM

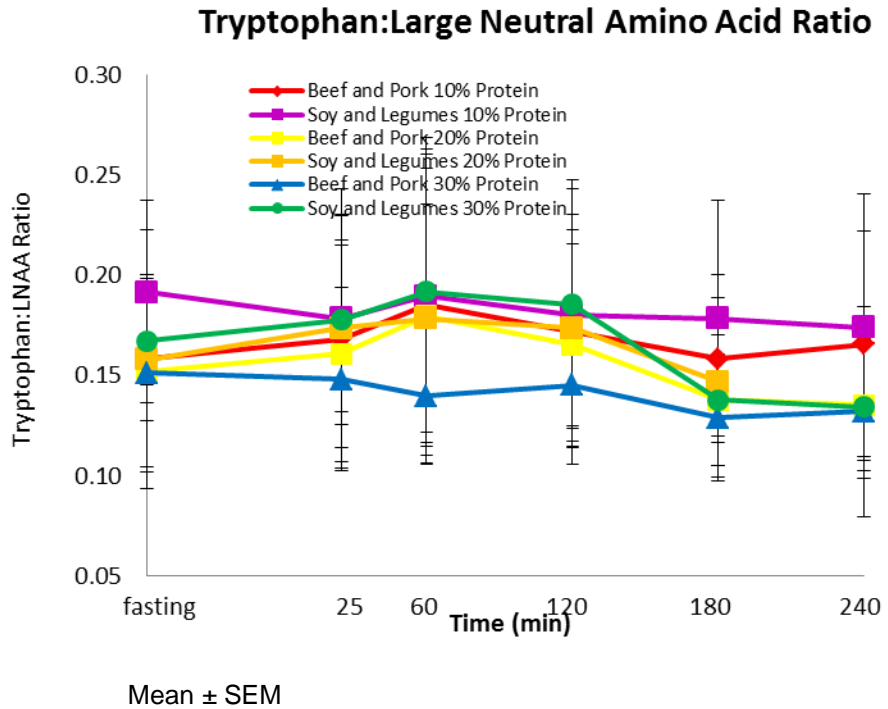
**Figure 12:** Leucine by predominate protein source and quantity.



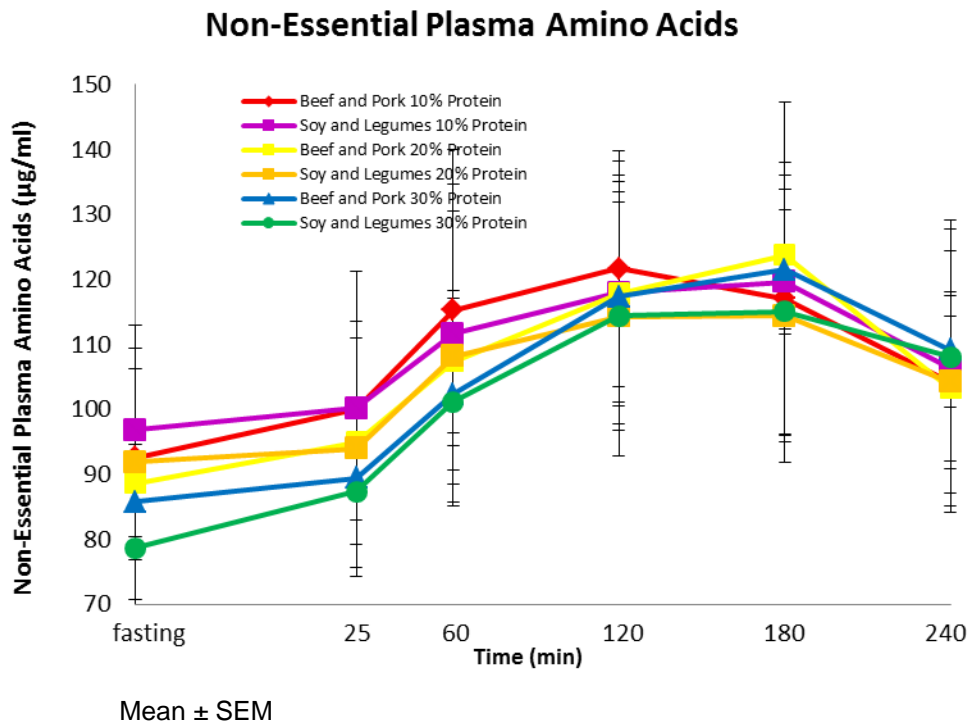
**Figure 13:** Tryptophan by predominate protein source and quantity.



**Figure 14:** Tryptophan:large neutral amino acid ratio by predominate protein source and quantity.



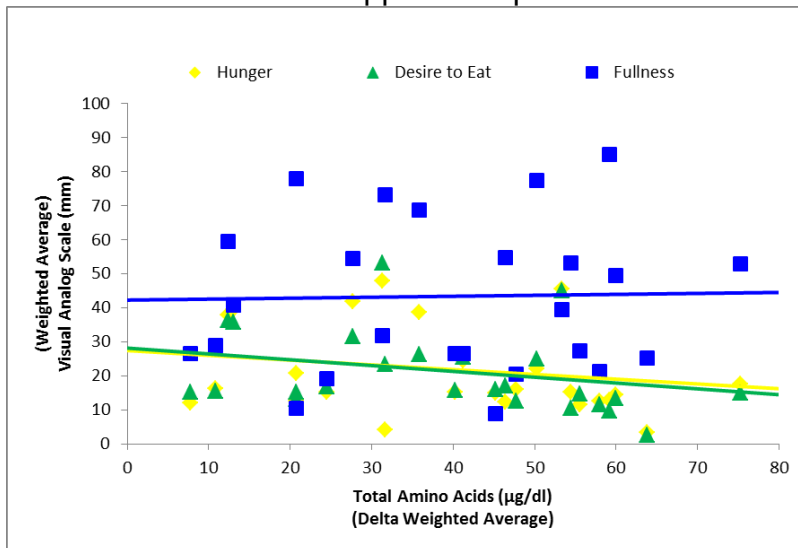
**Figure 15:** Non-essential amino acids by predominate protein source and quantity.



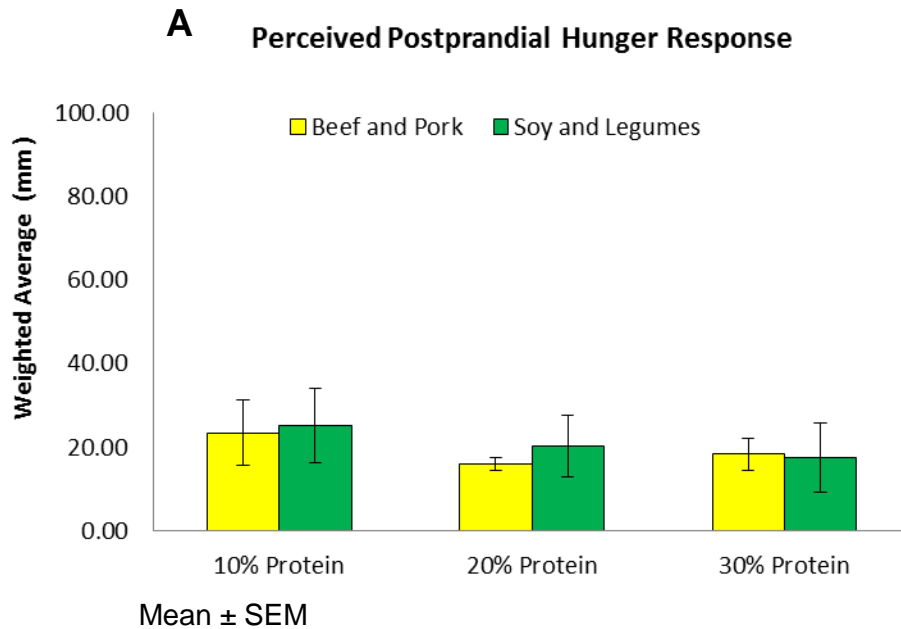
## Appetite:

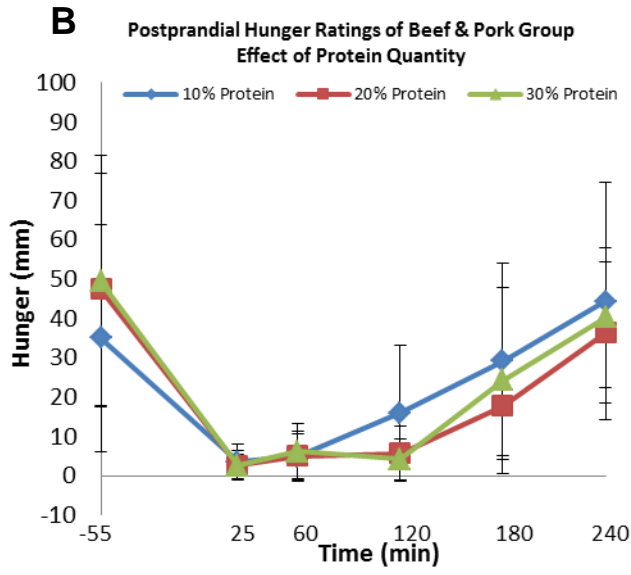
Postprandial appetite response (weighted averages) were not related postprandial total amino acid response (delta weighted average) (see Figure 16) Protein quantity and source did not affect postprandial appetite responses (weighted averages) (see Figures 17-19).

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

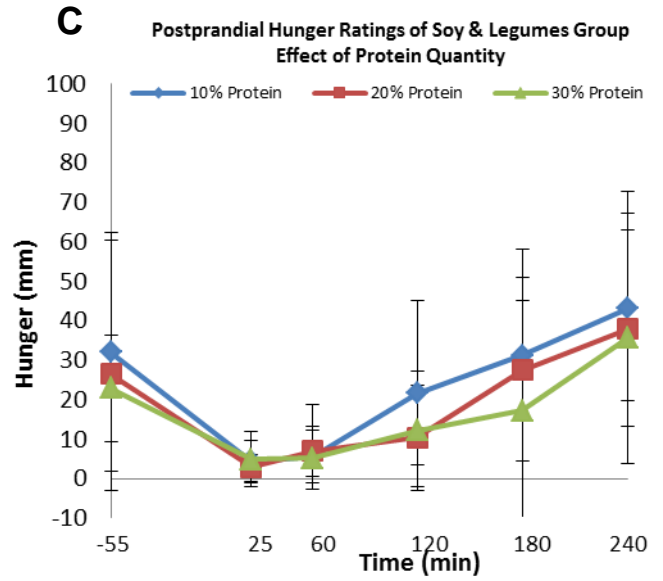


**Figure 16:** Postprandial hunger weighted average (A) and mean response (B and C) by predominate protein source and quantity.



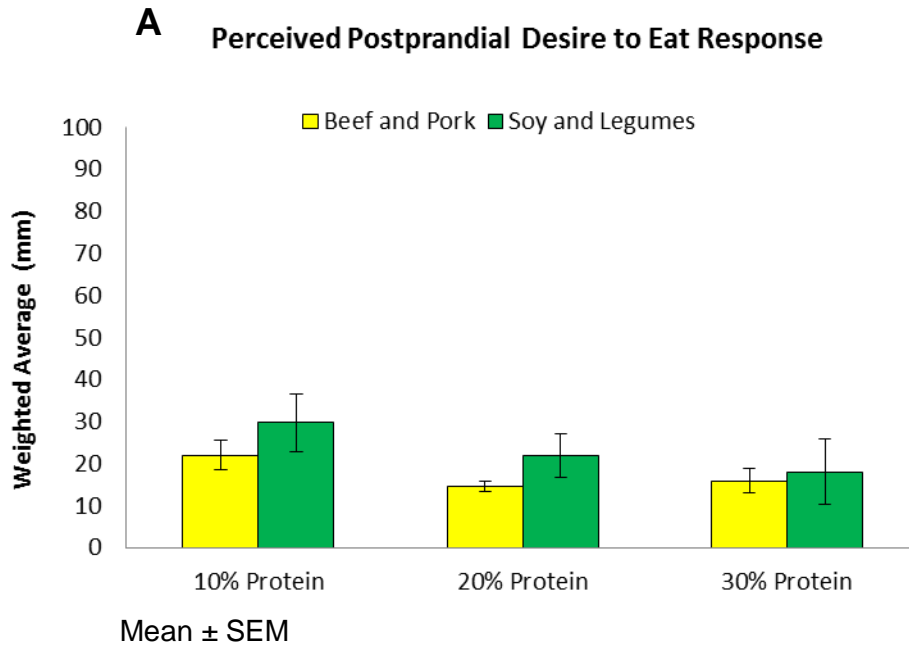


Mean  $\pm$  SEM

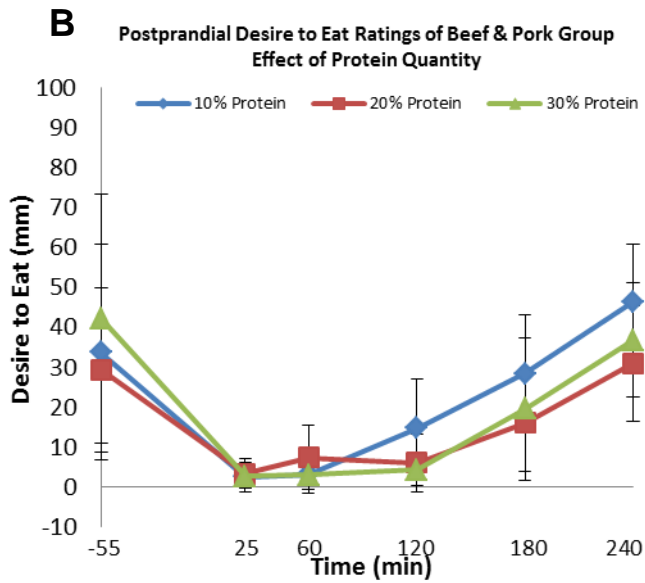


Mean  $\pm$  SEM

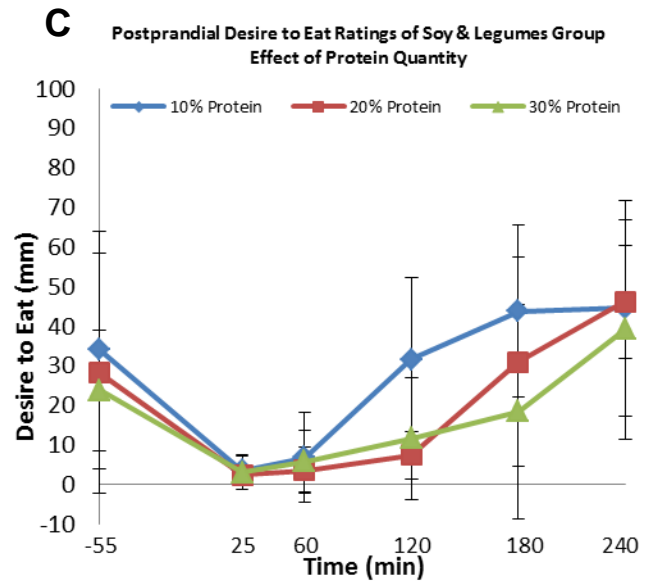
**Figure 17:** Postprandial desire to eat weighted average (A) and mean response (B and C) by predominate protein source and quantity.



Mean  $\pm$  SEM

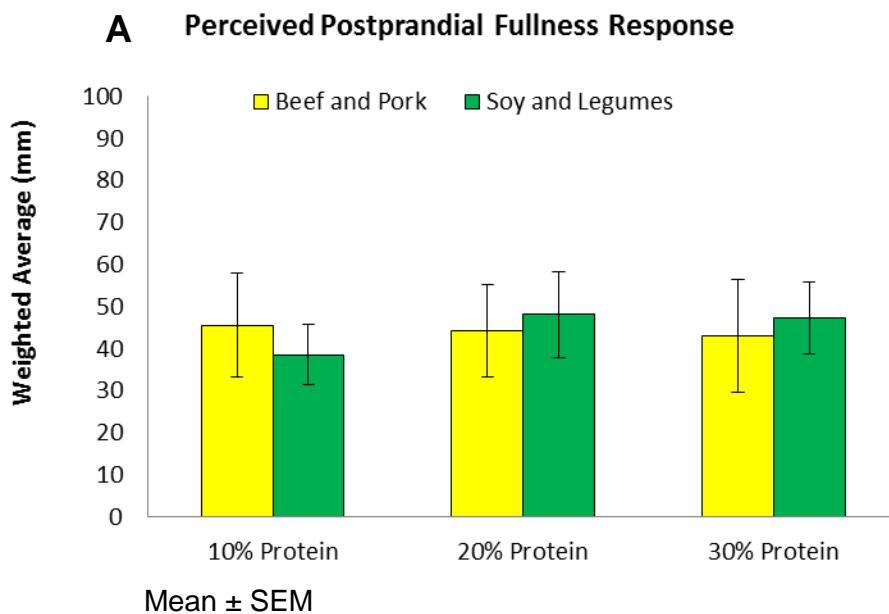


Mean  $\pm$  SEM



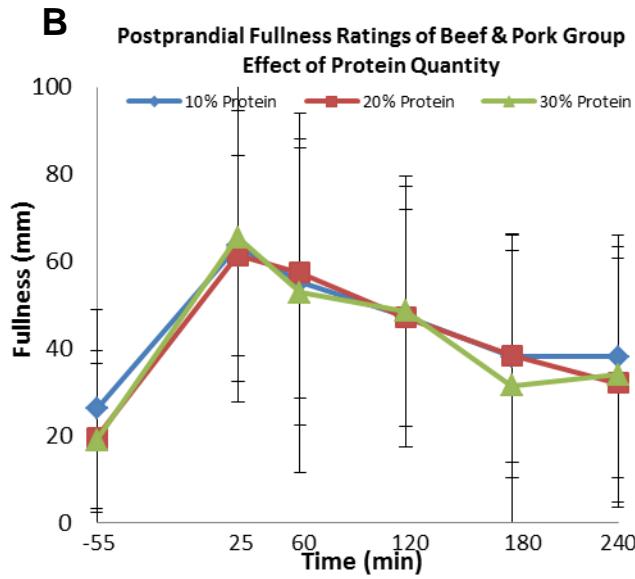
Mean  $\pm$  SEM

**Figure 18:** Postprandial fullness weighted average (A) and mean response (B and C) by predominate protein source and quantity.

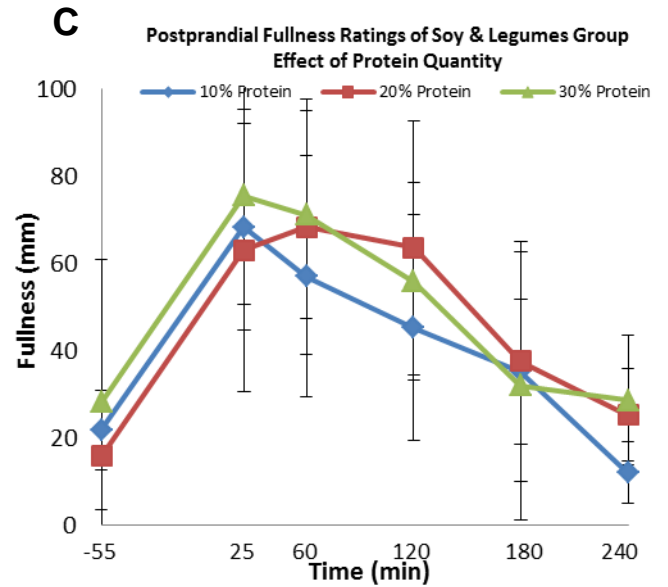


Mean  $\pm$  SEM





Mean  $\pm$  SEM

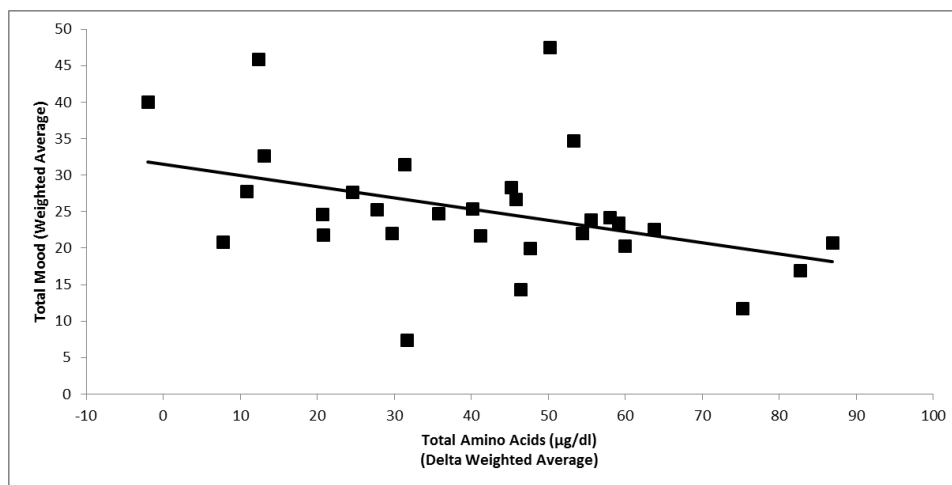


Mean  $\pm$  SEM

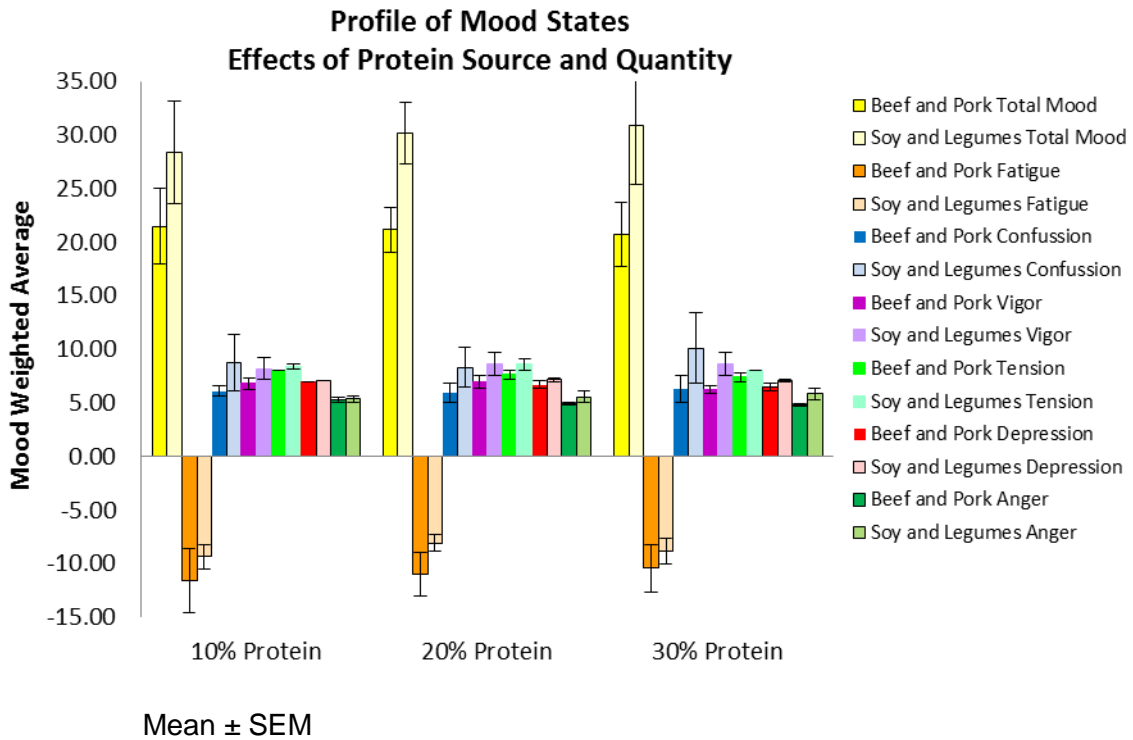
**Mood:**

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 19). 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 20-27).

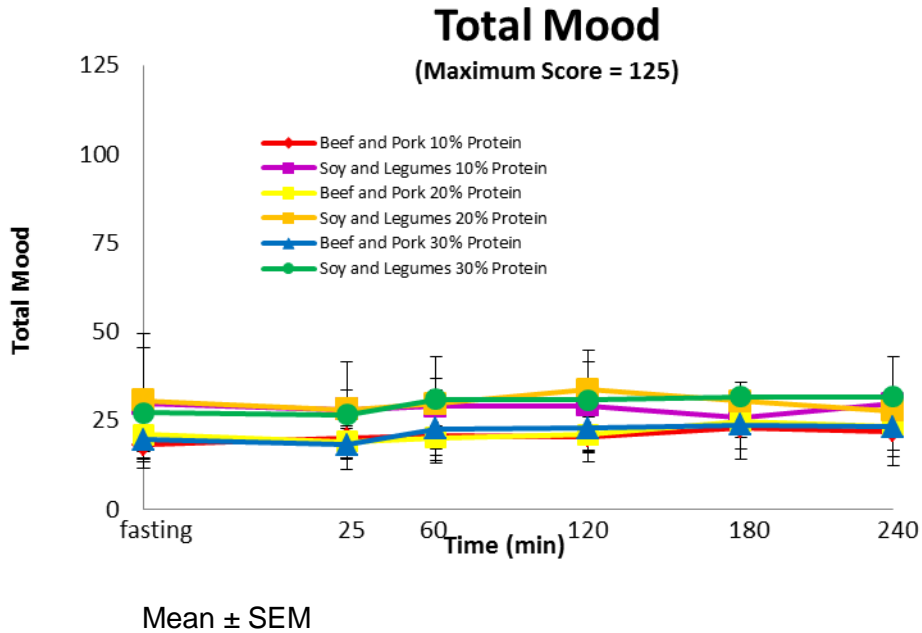
**Figure 19:** Correlation between total mood and total amino acids.



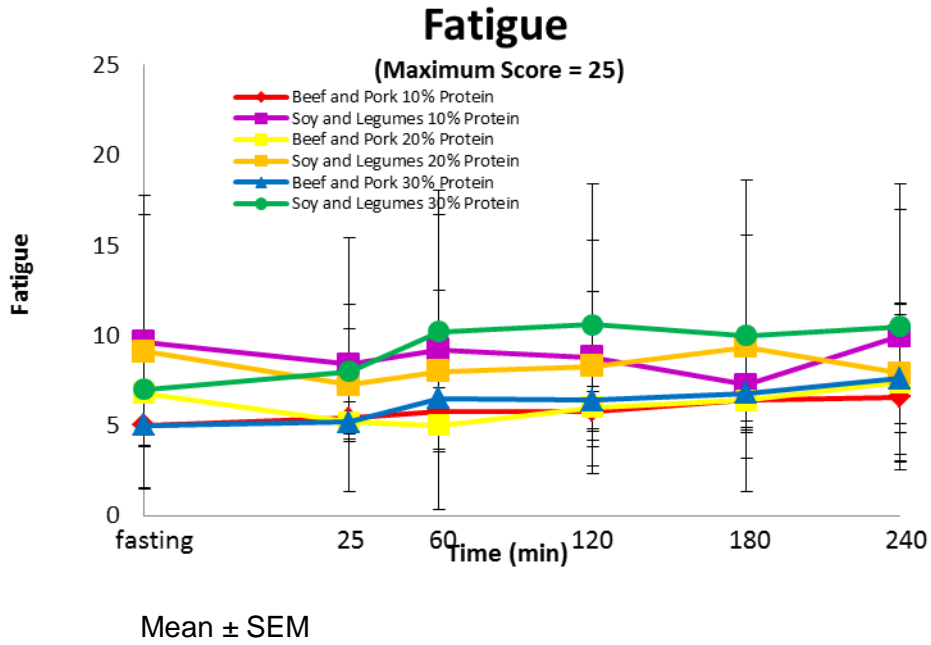
**Figure 20:** Profile of Mood States by total and POMS subcategory.



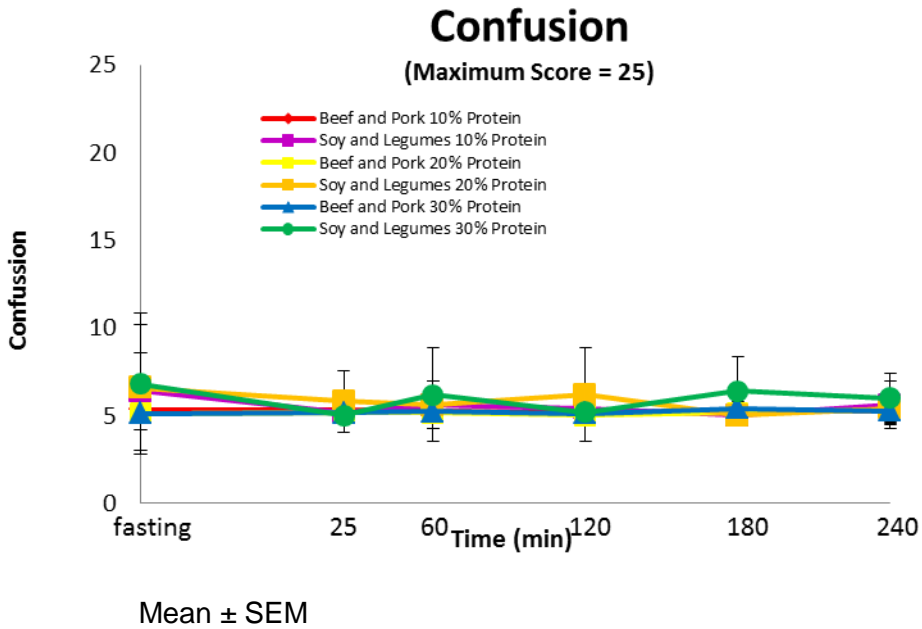
**Figure 21:** Total mood disturbance by predominate protein source and quantity.



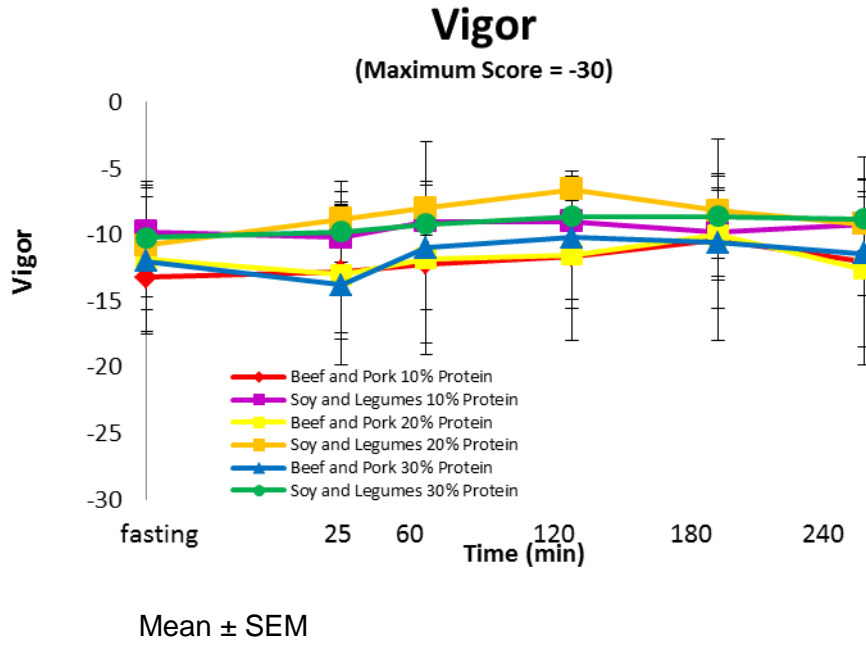
**Figure 22:** Fatigue response by predominate protein source and quantity.



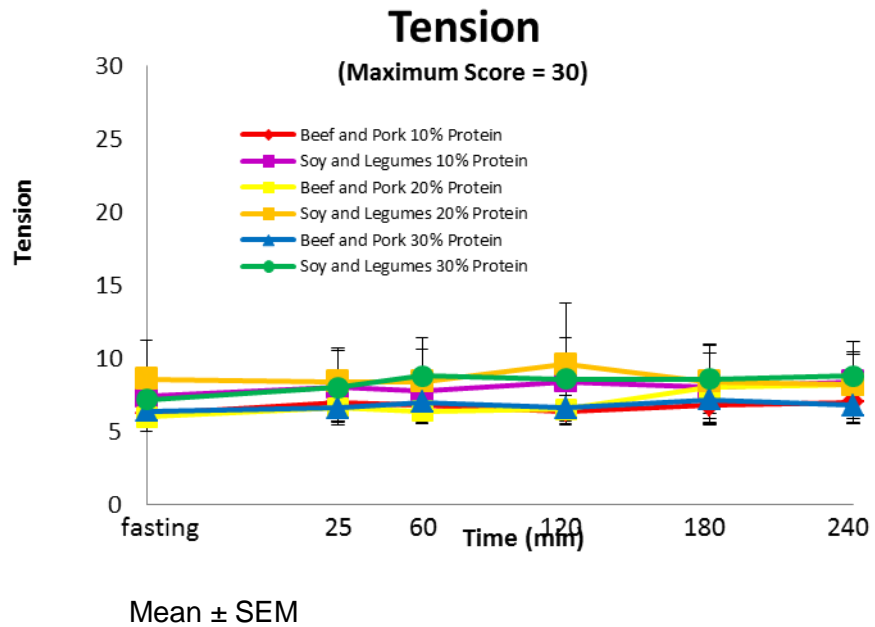
**Figure 23:** Confusion response by predominate protein source and quantity.



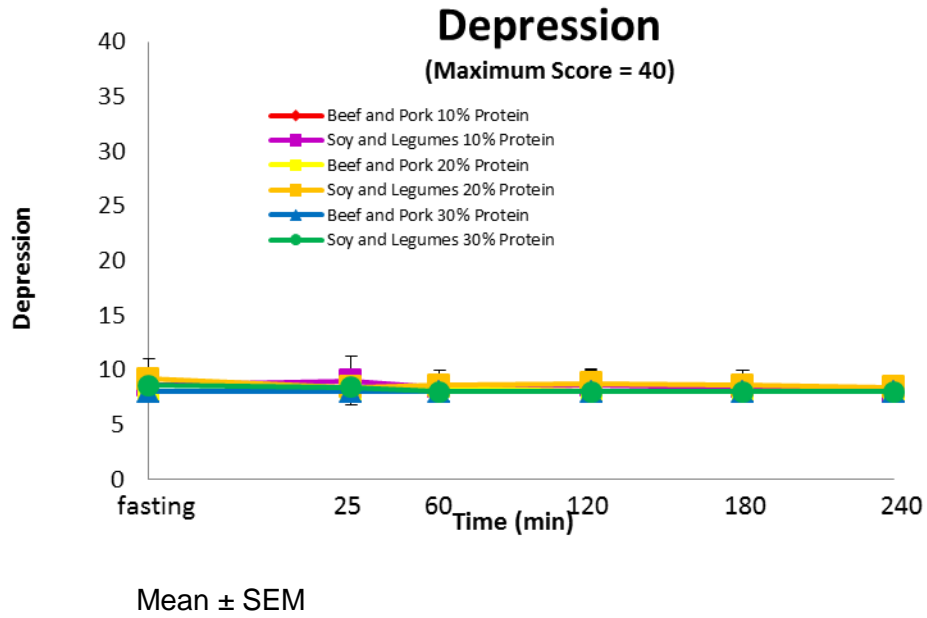
**Figure 24:** Vigor response by predominate protein source and quantity.



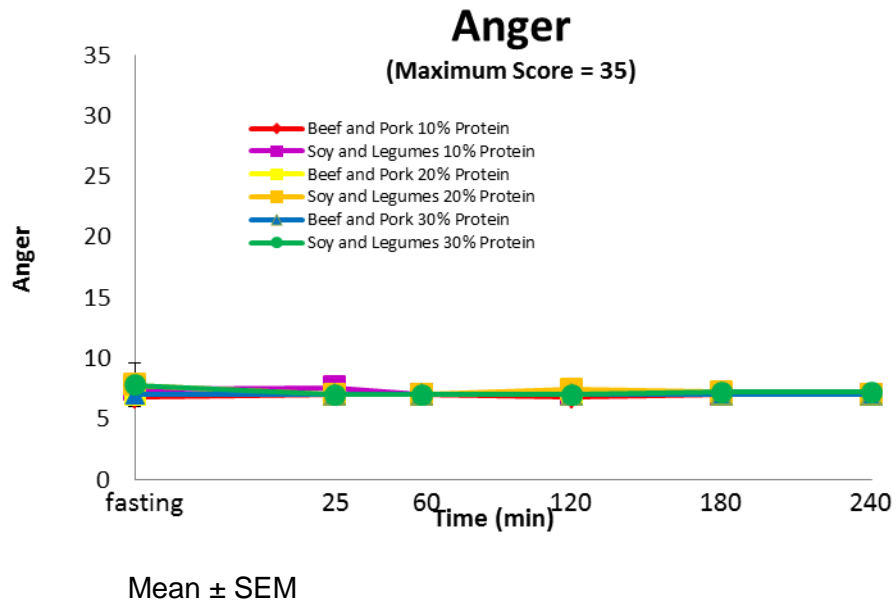
**Figure 25:** Tension response by predominate protein source and quantity.



**Figure 26:** Depression response by predominate protein source and quantity.

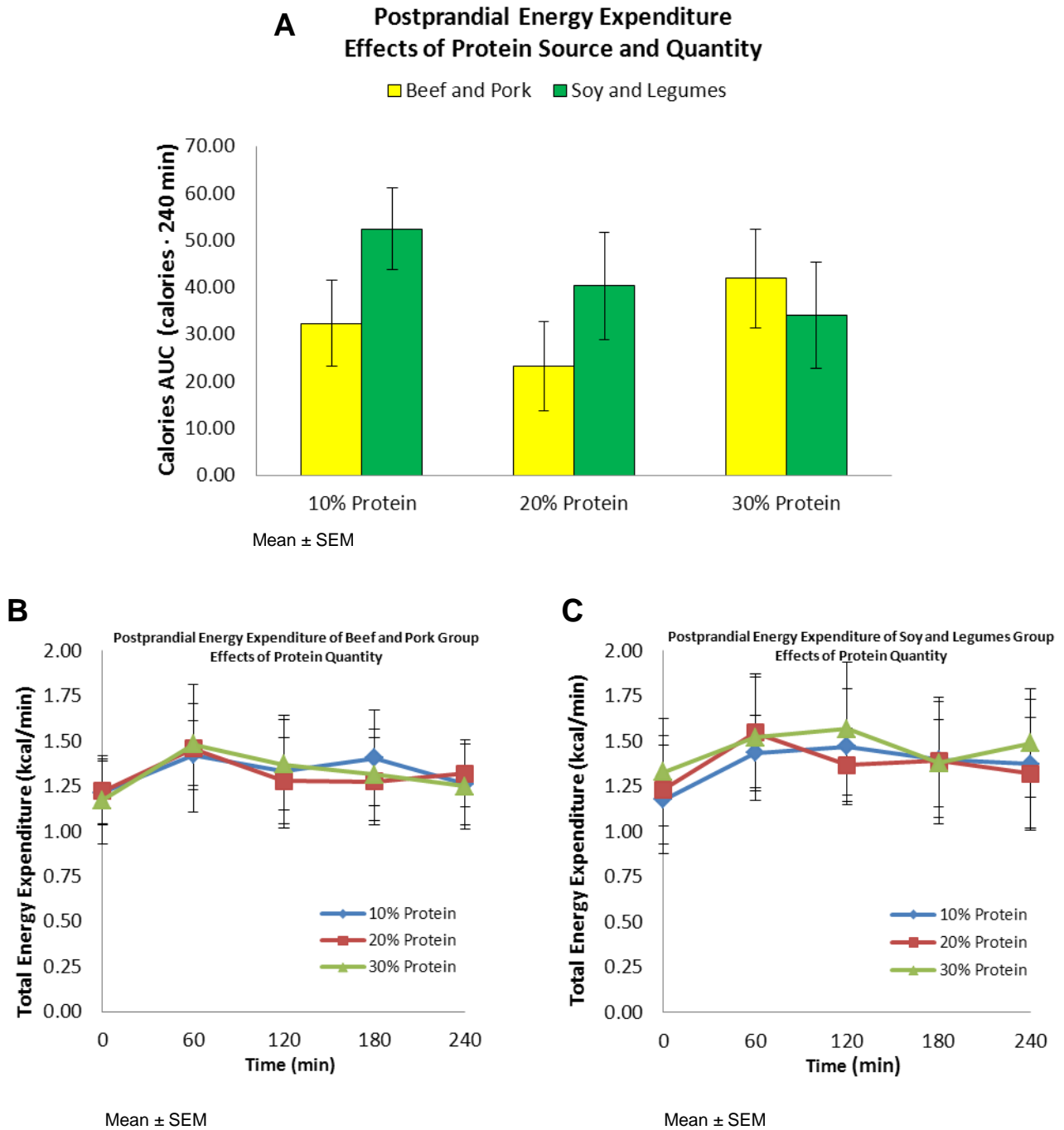


**Figure 27:** Anger response by predominate protein source and quantity.



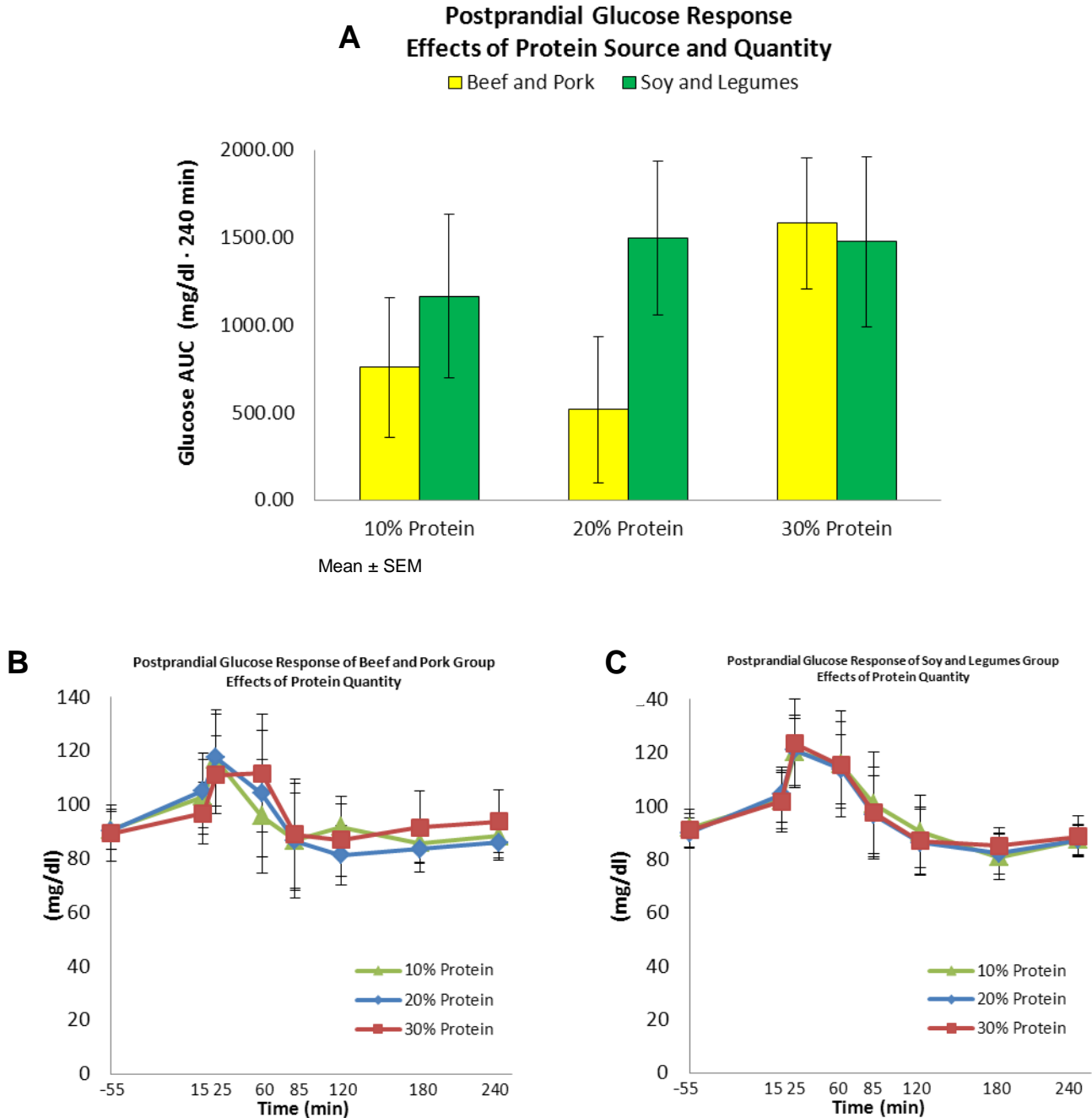
**Energy Expenditure:** Protein quantity and predominant source did not influence postprandial energy expenditure (Figure 28).

**Figure 28:** Postprandial energy expenditure area under the curve (**A**), and mean energy expenditure (**B** and **C**) by predominate protein source and quantity.

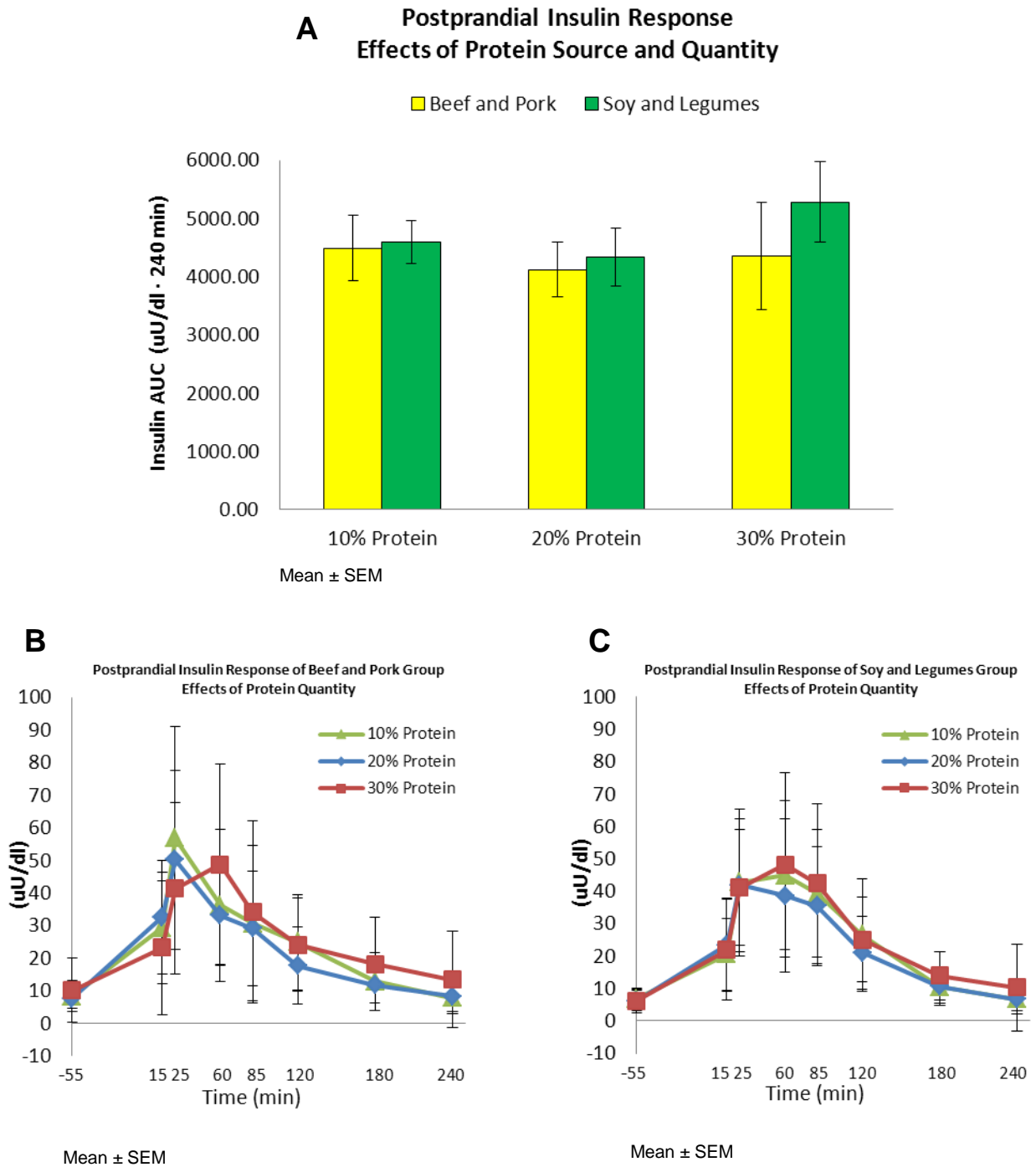


**Glycemic Response:** Protein quantity and predominant source did not influence postprandial glucose (Figure 29) or insulin (Figure 30) responses.

**Figure 29:** Postprandial glucose area under the curve (A), and mean response (B and C) by predominate protein source and quantity.



**Figure 30:** Postprandial insulin area under the curve (A), and mean response (B and C) by predominate protein source and quantity.

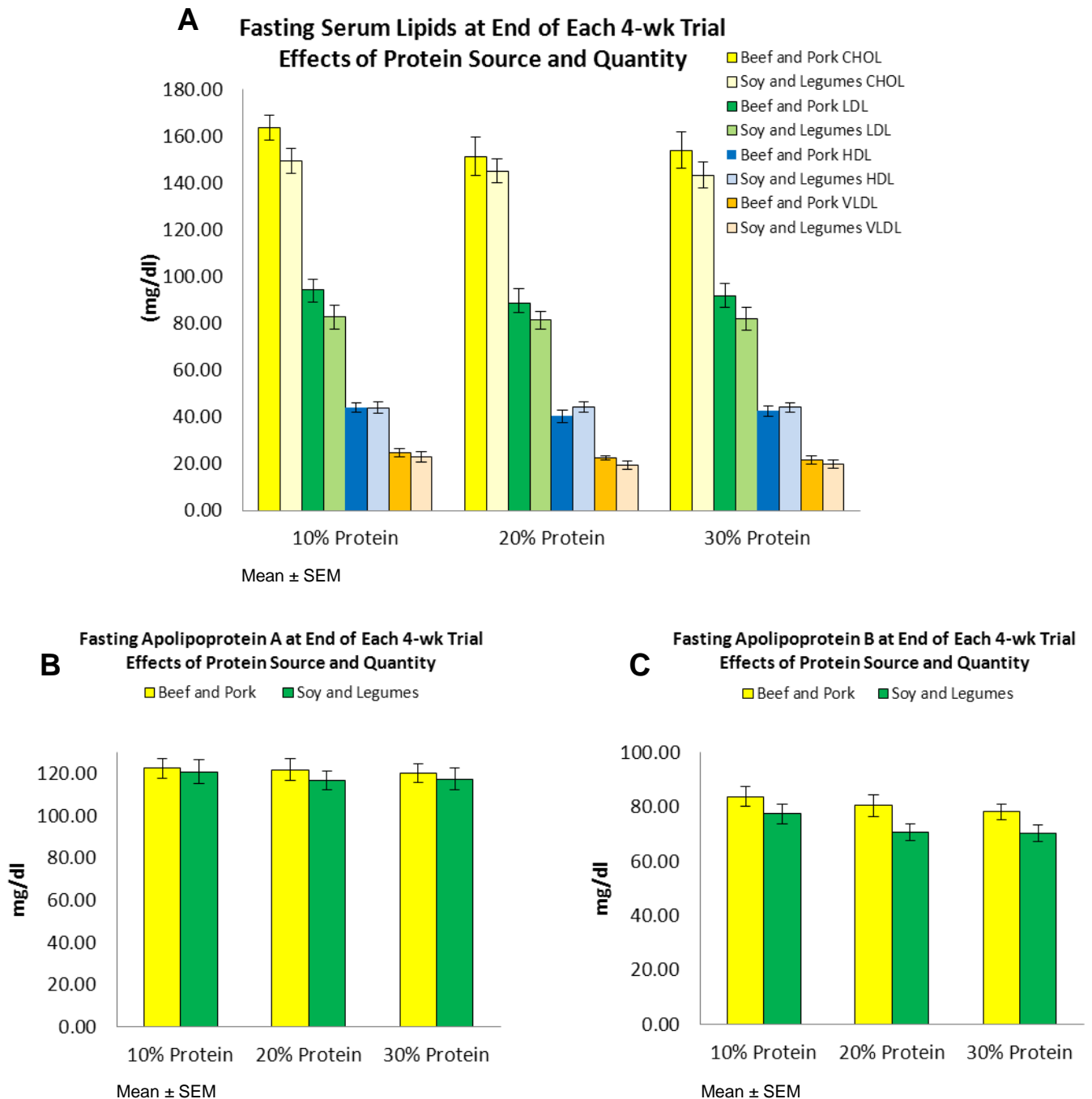




## Additional Measurements – Fasting Measurements at Baseline and Test Days

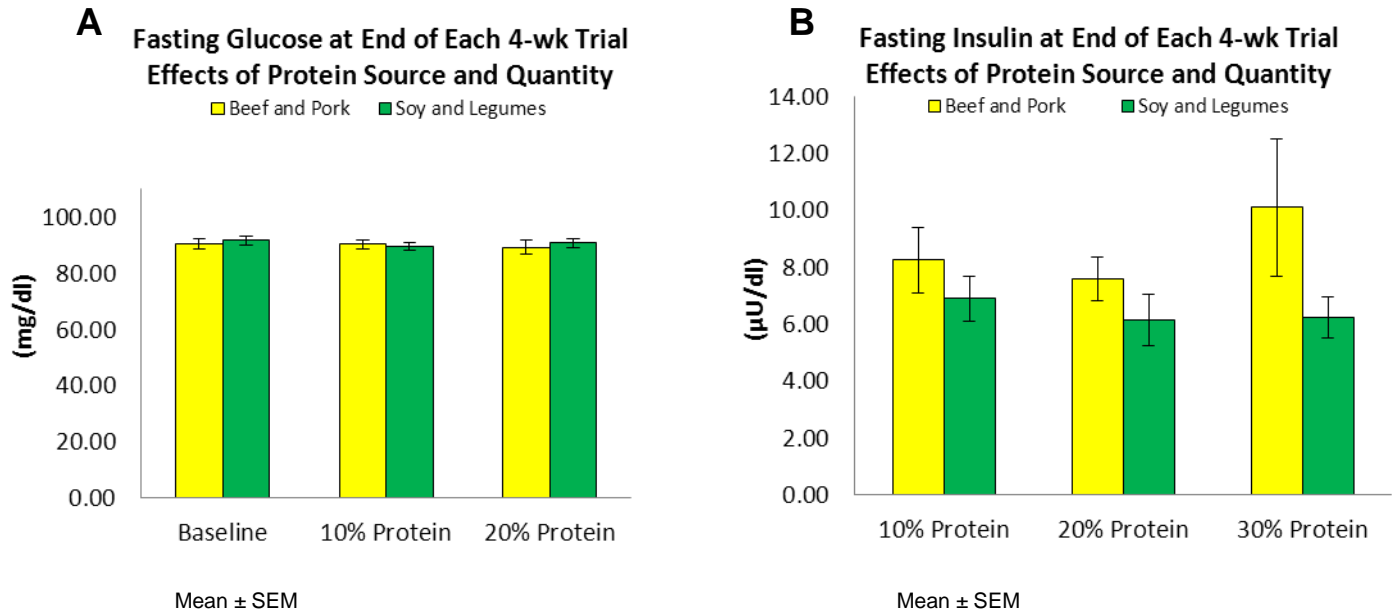
**Lipids:** Total cholesterol ( $p < 0.05$ ), VLDL ( $p < 0.01$ ) and apolipoprotein B ( $p < 0.01$ ) were lower at 20 and 30% protein, compared to 10% protein, independent of predominant protein source (Figure 31).

**Figure 31:** Fasting Serum Lipids (A), Apolipoprotein A (B), and Apolipoprotein B (C) by predominate protein source and quantity.



**Glucose and Insulin:** Fasting glucose and insulin at the end of each 4-wk trial were not affected by protein quantity or predominant source (Figure 32).

**Figure 32:** Fasting glucose (A) and insulin (B) by predominate protein source and quantity.



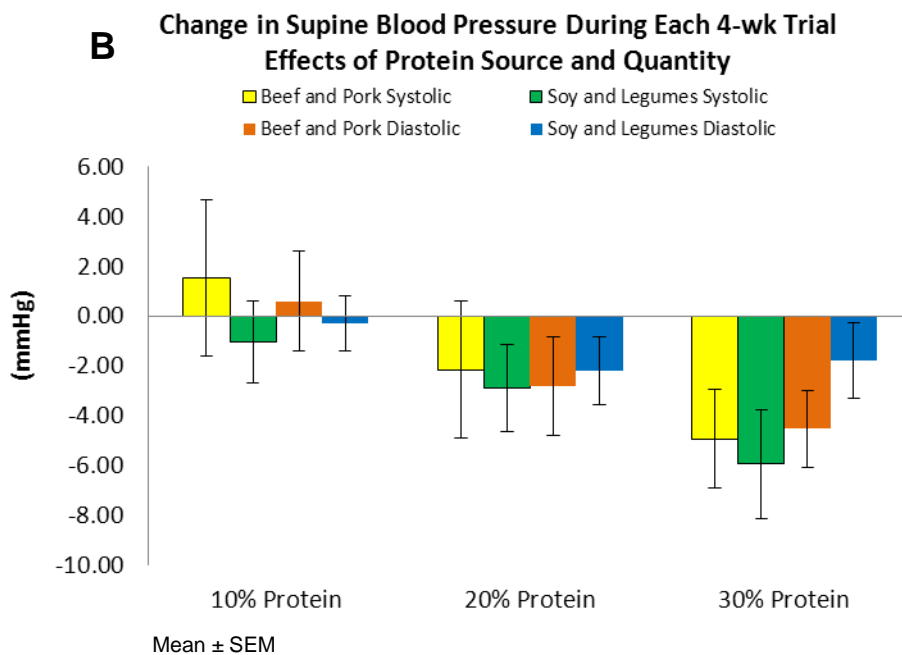
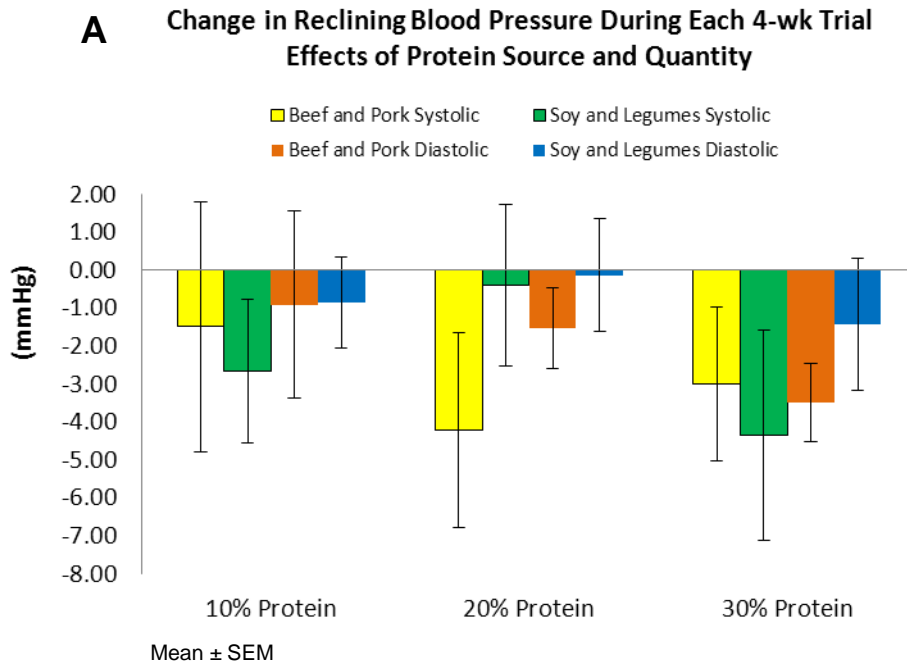
**Waist and Hip Circumference** (Table 4) was not significantly influenced by protein quantity or predominant source.

**Table 4:** Changes in Waist and Hip Circumferences During Each 4-wk Trial

	Group	10% Protein	20% Protein	30% Protein
<b>Natural Waist (mm)</b>	Beef and Pork	-32 ± 27	-27 ± 38	-16 ± 29
	Soy and Legumes	-27 ± 26	-22 ± 27	-23 ± 26
<b>Umbilicus (mm)</b>	Beef and Pork	-33 ± 44	-25 ± 31	-27 ± 36
	Soy and Legumes	-21 ± 35	-24 ± 18	-21 ± 28
<b>Hip (mm)</b>	Beef and Pork	-32 ± 78	-14 ± 41	-13 ± 58
	Soy and Legumes	-16 ± 20	-27 ± 31	-35 ± 42
<b>Natural Waist:Hip Ratio</b>	Beef and Pork	-0.0113 ± 0.0534	-0.0069 ± 0.0400	-0.0001 ± 0.0525
	Soy and Legumes	-0.0113 ± 0.0303	0.0094 ± 0.0294	0.0106 ± 0.0369

**Blood Pressure:** Changes in blood pressure from the beginning to end of each trial were not influenced by the quantity or predominant source of protein.

**Figure 33:** Changes in reclining (A) and supine (B) blood pressure 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:** Assess the effects of habitual protein intake from lean beef/pork or soy/pulses sources across the AMDR (10%, 20%, or 30% of energy) on indices of daily appetite (e.g. hunger, desire to eat, and fullness).

Contrary to expectations, the quantity of protein did not influence indices of daily appetite. These results are based on composite (area under the curve) analyses. Prior to publication, we will explore these data in more depth to evaluate average and within-day (morning, mid-day, and evening) timeframes.

**Aim 2:** Assess the effects of the quantity (10%, 20%, and 30% of energy) of protein from lean beef/pork or soy/pulses sources on postprandial appetite, energy expenditure, glycemic (plasma glucose and insulin) response, and plasma amino acid concentrations.

As hypothesized, the postprandial plasma amino acid responses were greater with increasing protein intake. Also, the postprandial reductions in hunger and desire to eat were more robust when the meals containing 30% energy from protein were consumed, independent of predominant source.

Contrary to expectation, the postprandial resting energy expenditure and glycemic (glucose and insulin) responses were not different among protein quantities, independent of predominant source.

**Aim 3:** Assess the relationship of the quantity (10%, 20%, and 30% of energy) of protein from lean beef/pork or soy/pulses sources between postprandial plasma amino acids and appetite (hunger, desire to eat, and fullness)

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 legumes.

Higher protein intake from lean beef/pork and soy/legumes 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.

## References

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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><b>Breakfast</b> Grapefruit Half <b>Ham &amp; Cheese Omelet</b> Toast with <b>Margarine &amp; Jam</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> Fresh Grapes <b>Strawberry Yogurt</b> Light Orange Juice Coffee</p>	<p><b>Breakfast</b> Banana Rice Krispies w/Skim Milk <b>Blueberry Muffin with Margarine</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> <b>Blueberries</b> Pancakes with <b>Syrup &amp; Margarine</b> <b>Canadian Bacon</b> Skim Milk Coffee</p>	<p><b>Breakfast</b> Grapefruit Half Scrambled Eggs English Muffin with <b>Margarine &amp; Jam</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> Banana Bagel with <b>Cream Cheese</b> Light Orange Juice Coffee</p>	<p><b>Breakfast</b> <b>Blueberries</b> Waffles with <b>Syrup &amp; Margarine</b> Skim Milk Coffee</p>
<p><b>Lunch</b> <b>Roast Beef</b> Sandwich with Cheese, Lettuce &amp; Tomato, <b>Mayonnaise</b> Pringles Diced Pears Diet Soda</p>	<p><b>Lunch</b> <b>Spinach &amp; Ham Quiche</b> Fresh Baby Carrots with <b>Vegetable Dip</b> Fresh Apple Welch’s Fruit Snack <b>Crystal Light</b></p>	<p><b>Lunch</b> Chef Salad with <b>Dressing (Ham, Cheese, and Egg)</b> Wheat Thin Toasted Chips Mixed Fruit Cup Diet Soda</p>	<p><b>Lunch</b> <b>Pork Tenderloin</b> Sandwich with Provolone Cheese, Lettuce &amp; Tomato, <b>Mayonnaise</b> Harvest Cheddar Sun Chips Fruited Gelatin <b>Crystal Light</b></p>	<p><b>Lunch</b> Hard <b>Beef</b> Taco with Lettuce &amp; Tomato <b>Chips &amp; Salsa</b> Frozen Fruit Bar Diet Soda</p>	<p><b>Lunch</b> Tomato Soup Grilled <b>Ham &amp; Cheese</b> Sandwich Fresh Celery Sticks with <b>Vegetable Dip</b> Pringles Fresh Apple <b>Crystal Light</b></p>	<p><b>Lunch</b> Garden Salad with <b>Dressing</b> <b>Ham &amp; Pasta Carbanero</b> Mixed Fruit Cup <b>Crystal Light</b></p>
<p><b>Snack</b> <b>Hershey Almond Kisses</b> <b>Crystal Light</b></p>	<p><b>Snack</b> Quaker Oats Granola Bar Diet Soda</p>	<p><b>Snack</b> Whole Grain Goldfish <b>Crystal Light</b></p>	<p><b>Snack</b> 100 kcal Keebler Striped Cookies Diet Soda</p>	<p><b>Snack</b> Quaker Oats Granola Bar <b>Crystal Light</b></p>	<p><b>Snack</b> <b>Hershey Almond Kisses</b> Diet Soda</p>	<p><b>Snack</b> Whole Grain Goldfish Diet Soda</p>
<p><b>Dinner</b> Garden Salad with <b>Dressing</b> <b>Roast Pork Tenderloin</b> Candied Sweet Potatoes with <b>Mini Marshmallows</b> Green Beans Dinner Roll with <b>Margarine</b> Fruited Gelatin with Whipped Topping Ice Tea</p>	<p><b>Dinner</b> Southwestern <b>Beef</b> Salad with Lettuce, Tomato, <b>Ranch Dressing</b> and Salsa <b>Fritos</b> Mandarin Oranges Frozen Fruit Bar Ice Tea</p>	<p><b>Dinner</b> <b>Roast Beef Tenderloin</b> Mashed Potatoes with Gravy Carrots Dinner Roll with <b>Margarine</b> <b>Yellow Cake</b> with <b>Fruit Topping</b> Ice Tea</p>	<p><b>Dinner</b> Caesar Salad with Dressing <b>Spaghetti &amp; Beefsauce</b> Garlic Toast Fresh Grapes Lemon Sorbet Ice Tea</p>	<p><b>Dinner</b> <b>Sliced Ham</b> Roasted Red Potatoes Broccoli, Cauliflower &amp; Carrots in Cheese Sauce Dinner Roll with <b>Margarine</b> <b>Apple Crisp</b> Ice Tea</p>	<p><b>Dinner</b> <b>BBQ Beef Brisket</b> Mashed Potatoes Whole Kernel Corn Vanilla Ice Cream with <b>Fruit Topping</b> Ice Tea</p>	<p><b>Dinner</b> <b>Asian Beef Stir fry</b> Brown Rice Pineapple Pecan Sandies Ice Tea</p>
<p><b>Snack</b> Klondike Slim-a-Bear Ice Cream Sandwich Water</p>	<p><b>Snack</b> 100 kcal Jell-O Pudding Water</p>	<p><b>Snack</b> Smartfood Cheese Popcorn Diet Soda</p>	<p><b>Snack</b> Klondike Slim-a-Bear Ice Cream Sandwich Water</p>	<p><b>Snack</b> 100 kcal Jell-O Pudding Water</p>	<p><b>Snack</b> Smartfood Cheese Popcorn Diet Soda</p>	<p><b>Snack</b> 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><b>Breakfast</b> Grapefruit Half <b>Ham and Cheese Omelet</b> <b>Canadian Bacon</b> Toast with <b>Jam</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> Fresh Grapes Strawberry Yogurt with <b>Granola</b> Light Orange Juice Coffee</p>	<p><b>Breakfast</b> Banana Special K w/Skim Milk <b>Blueberry Muffin</b> <b>Canadian Bacon</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> <b>Blueberries</b> <b>Pancakes</b> with Diet Syrup <b>Canadian Bacon</b> Skim Milk Coffee</p>	<p><b>Breakfast</b> Grapefruit Half Scrambled Eggs <b>Canadian Bacon</b> English Muffin with <b>Jam</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> Banana Bagel with <b>Cream Cheese</b> <b>Canadian Bacon</b> Light Orange Juice Skim Milk Coffee</p>	<p><b>Breakfast</b> <b>Blueberries</b> Waffles with Diet Syrup <b>Canadian Bacon</b> Skim Milk Coffee</p>
<p><b>Lunch</b> <b>Roast Beef</b> Sandwich with Cheese, Lettuce &amp; Tomato, <b>Mayonnaise</b> Pringles Diced Pears Diet Soda</p>	<p><b>Lunch</b> <b>Spinach &amp; Ham Quiche</b> Fresh Baby Carrots with <b>Vegetable Dip</b> Fresh Apple <b>Crystal Light</b></p>	<p><b>Lunch</b> Chef Salad with <b>Dressing</b> (<b>Ham</b>, Cheese, and Egg) Melba Rounds Mixed Fruit Cup Diet Soda</p>	<p><b>Lunch</b> <b>Pork Tenderloin</b> Sandwich with Provolone Cheese, Lettuce &amp; Tomato, <b>Mayonnaise</b> Harvest Cheddar Sun Chips Sugar Free Gelatin <b>Crystal Light</b></p>	<p><b>Lunch</b> Soft <b>Beef</b> Taco with Lettuce, Tomato &amp; Cheese <b>Chips &amp; Salsa</b> Frozen Fruit Bar Diet Soda</p>	<p><b>Lunch</b> Cream of Tomato Soup Grilled <b>Ham &amp; Cheese</b> <b>Sandwich</b> Fresh Celery Sticks with <b>Vegetable Dip</b> Pringles Sugar Free Gelatin <b>Crystal Light</b></p>	<p><b>Lunch</b> Garden Salad with <b>Dressing</b> <b>Ham &amp; Pasta Carbanero</b> Mixed Fruit Cup <b>Crystal Light</b></p>
<p><b>Snack</b> Cocoa Roasted Almonds <b>Crystal Light</b></p>	<p><b>Snack</b> <b>Homemade Granola</b> Diet Soda</p>	<p><b>Snack</b> <b>Cheese Twist Crackers</b> <b>Crystal Light</b></p>	<p><b>Snack</b> Kroger Traditional Chex Mix Diet Soda</p>	<p><b>Snack</b> <b>Homemade Granola</b> <b>Crystal Light</b></p>	<p><b>Snack</b> Cocoa Roasted Almonds Diet Soda</p>	<p><b>Snack</b> <b>Cheese Twist Crackers</b> Diet Soda</p>
<p><b>Dinner</b> Garden Salad with <b>Dressing</b> <b>Roast Pork Tenderloin</b> Candied Sweet Potatoes with <b>Mini Marshmallows</b> Green Beans Dinner Roll with <b>Margarine</b> Sugar Free Gelatin with Whipped Topping Ice Tea</p>	<p><b>Dinner</b> Southwestern <b>Beef</b> Salad with Lettuce, Cheese, &amp; Salsa <b>Fritos</b> Mandarin Oranges Frozen Fruit Bar Ice Tea</p>	<p><b>Dinner</b> <b>Roast Beef Tenderloin</b> Sautéed Mushrooms Mashed Potatoes with Gravy Broccoli Spears Dinner Roll with <b>Margarine</b> <b>Angle Food Cake</b> with <b>Fruit Topping</b> Ice Tea</p>	<p><b>Dinner</b> Caesar Salad with Dressing <b>Spaghetti &amp; Beefsauce</b> Green Beans Garlic Toast Lemon Sorbet Ice Tea</p>	<p><b>Dinner</b> <b>Sliced Ham</b> Roasted Red Potatoes Broccoli, Cauliflower &amp; Carrots in Cheese Sauce Dinner Roll with <b>Margarine</b> <b>Apple Crisp</b> Ice Tea</p>	<p><b>Dinner</b> <b>BBQ Beef Brisket</b> Mashed Potatoes Whole Kernel Corn Dinner Roll with <b>Margarine</b> Vanilla Ice Cream with <b>Fruit Topping</b> Ice Tea</p>	<p><b>Dinner</b> <b>Asian Beef Stir fry</b> Brown Rice Fresh Pineapple Pecan Sandies Ice Tea</p>
<p><b>Snack</b> Skinny Cow Truffle Bar Water</p>	<p><b>Snack</b> <b>Sugar Free Jell-O</b> <b>Pudding</b> Water</p>	<p><b>Snack</b> Microwave Popcorn Diet Soda</p>	<p><b>Snack</b> Skinny Cow Truffle Bar Water</p>	<p><b>Snack</b> <b>Sugar Free Jell-O</b> <b>Pudding</b> Water</p>	<p><b>Snack</b> Microwave Popcorn Diet Soda</p>	<p><b>Snack</b> <b>Sugar Free Jell-O</b> <b>Pudding</b> 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><b>Breakfast</b> Grapefruit Sections Southwestern Scrambled Eggs with Cheese <b>Canadian Bacon</b> Whole Wheat Toast &amp; <b>Jam</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> Yogurt with <b>Almonds</b>, <b>Wheat Germ &amp;</b> <b>Cranberries</b> <b>Naked Very Berry Juice</b> Coffee</p>	<p><b>Breakfast</b> <b>Melon Balls</b> Cottage Cheese with <b>Jam</b> <b>Blueberry Muffin</b> <b>Canadian Bacon</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> Raspberries with Yogurt <b>Pancakes</b> with Diet Syrup <b>Canadian Bacon</b> <b>Naked Very Berry Juice</b> Coffee</p>	<p><b>Breakfast</b> Grapefruit Sections Southwestern Scrambled Eggs with Cheese <b>Canadian Bacon</b> English Muffin &amp; <b>Jam</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> Yogurt with <b>Almonds</b>, <b>Wheat Germ &amp;</b> <b>Cranberries</b> <b>Naked Very Berry Juice</b> Coffee</p>	<p><b>Breakfast</b> <b>Raspberries</b> with Yogurt <b>Pancakes</b> with Diet Syrup <b>Canadian Bacon</b> <b>Naked Very Berry Juice</b> Coffee</p>
<p><b>Lunch</b> <b>Roast Beef</b> Wrap with Lettuce, Spinach, Red Pepper, Cheese &amp; Tomato <b>Light Ranch Dressing</b> <b>Pretzels</b> <b>Naked Very Berry Juice</b> Diet Soda</p>	<p><b>Lunch</b> <b>Spinach &amp; Ham Quiche</b> Fresh Baby Carrots with <b>Vegetable Dip</b> Cottage Cheese &amp; Peaches <b>Crystal Light</b></p>	<p><b>Lunch</b> Garden Vegetable Soup Chef Salad with Dressing (<b>Ham</b>, Cheese and Egg) Sesame Crackers Sugar Free Gelatin Diet Soda</p>	<p><b>Lunch</b> <b>Pork Tenderloin</b> Wrap with Lettuce, Spinach, Red Pepper, Cheese &amp; Tomato <b>Light Ranch Dressing</b> <b>Pretzels</b> Philly Swirl Cream Pop <b>Crystal Light</b></p>	<p><b>Lunch</b> <b>Beef Fajita</b> Salad <b>Chips &amp; Salsa</b> Mandarin Oranges Sugar Free Popsicle Diet Soda</p>	<p><b>Lunch</b> Cream of Tomato Soup <b>Grilled Ham Sandwich</b> Fresh Celery Sticks with <b>Vegetable Dip</b> Sugar Free Gelatin <b>Crystal Light</b></p>	<p><b>Lunch</b> Spinach Salad with <b>Dressing</b> <b>Ham &amp; Pasta Primavera</b> Philly Swirl Cream Pop <b>Crystal Light</b></p>
<p><b>Snack</b> Cheese and Crackers <b>Crystal Light</b></p>	<p><b>Snack</b> <b>Homemade Granola</b> Diet Soda</p>	<p><b>Snack</b> <b>Pumpkin Seed Crackers</b> <b>Crystal Light</b></p>	<p><b>Snack</b> <b>Pasta Chips</b> Diet Soda</p>	<p><b>Snack</b> <b>Homemade Granola</b> <b>Crystal Light</b></p>	<p><b>Snack</b> Cheese and Crackers Diet Soda</p>	<p><b>Snack</b> <b>Pumpkin Seed Crackers</b> Diet Soda</p>
<p><b>Dinner</b> Garden Salad with <b>Dressing</b> <b>Roast Pork Tenderloin</b> Candied Sweet Potatoes with <b>Mini Marshmallows</b> Asparagus Whole Wheat Bread with <b>Margarine</b> Sugar Free Gelatin with Whipped Topping Ice Tea</p>	<p><b>Dinner</b> Southwestern <b>Beef</b> Salad with Lettuce, Spinach, Cheese &amp; Salsa <b>Fritos</b> Mandarin Oranges Sugar Free Popsicle Ice Tea</p>	<p><b>Dinner</b> <b>Roast Beef Tenderloin</b> Sautéed Mushrooms Mashed Potatoes with Gravy Broccoli Spears Whole Wheat Bread with <b>Margarine</b> <b>Angel Food Cake</b> Ice Tea</p>	<p><b>Dinner</b> Caesar Salad with Dressing <b>Spaghetti &amp; Beefsauce</b> Brussels Sprouts Garlic Toast <b>Melon Balls</b> Ice Tea</p>	<p><b>Dinner</b> <b>Sliced Ham</b> Parmesan Red Potatoes Broccoli, Cauliflower &amp; Carrots w/ Cheese Sauce Whole Wheat Bread Whole Wheat Bread Pineapple Chunks Ice Tea</p>	<p><b>Dinner</b> <b>BBQ Beef Brisket</b> Mashed Potatoes Brussels Sprouts Whole Wheat Bread with <b>Margarine</b> Vanilla Ice Cream Ice Tea</p>	<p><b>Dinner</b> <b>Asian Beef Stir fry</b> Soba Noodles Pineapple Chunks <b>Sugar Free Shortbread</b> <b>Cookies</b> Ice Tea</p>
<p><b>Snack</b> Frozen Fruit Smoothie Water</p>	<p><b>Snack</b> <b>Sugar Free Jell-O Pudding</b> Water</p>	<p><b>Snack</b> <b>Cheesy Herb Popcorn</b> Diet Soda</p>	<p><b>Snack</b> Frozen Fruit Smoothie Water</p>	<p><b>Snack</b> <b>Sugar Free Jell-O Pudding</b> Water</p>	<p><b>Snack</b> <b>Cheesy Herb Popcorn</b> Diet Soda</p>	<p><b>Snack</b> <b>Sugar Free Jell-O Pudding</b> 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><b>Breakfast</b> Grapefruit Half <b>Southwestern Cheese Omelet</b> <b>Morningstar Organic Breakfast Pattie</b> Toast with <b>Margarine &amp; Jam</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> Fresh Grapes Strawberry Yogurt Light Orange Juice Coffee</p>	<p><b>Breakfast</b> Banana Rice Krispies with Skim Milk <b>Blueberry Muffin with Margarine</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> <b>Blueberries</b> Pancakes with Syrup &amp; <b>Margarine</b> <b>Morningstar Organic Breakfast Pattie</b> Skim Milk Coffee</p>	<p><b>Breakfast</b> Grapefruit Half Scrambled Eggs English Muffin with <b>Margarine &amp; Jam</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> Banana Bagel with <b>Cream Cheese</b> Light Orange Juice Coffee</p>	<p><b>Breakfast</b> <b>Blueberries</b> Waffles with <b>Syrup &amp; Margarine</b> Skim Milk Coffee</p>
<p><b>Lunch</b> <b>Tofurky “Philly Steak”</b> Sandwich with Cheese, Lettuce &amp; Tomato <b>Mayonnaise</b> Pringles Diced Pears Diet Soda</p>	<p><b>Lunch</b> <b>Spinach &amp; Morningstar Sausage Crumbles Quiche</b> Fresh Baby Carrots with <b>Vegetable Dip</b> Fresh Apple Welch’s Fruit Snack <b>Crystal Light</b></p>	<p><b>Lunch</b> Chef Salad with Dressing (<b>Tofurky “Hickory Smoked”</b>, Cheese, and Egg) Wheat Thin Toasted Chips Mixed Fruit Cup Diet Soda</p>	<p><b>Lunch</b> <b>Tofurky “Italian” Sandwich</b> with Provolone Cheese, Lettuce &amp; Tomato, <b>Mayonnaise</b> Harvest Cheddar Sun Chips Fruited Gelatin <b>Crystal Light</b></p>	<p><b>Lunch</b> Hard Taco with <b>Morningstar Sausage Crumbles</b>, Lettuce &amp; Tomato <b>Chips &amp; Salsa</b> Frozen Fruit Bar Diet Soda</p>	<p><b>Lunch</b> Tomato Soup Grilled <b>Tofurky “Hickory Smoked”</b> &amp; Cheese Sandwich Fresh Celery Sticks with <b>Vegetable Dip</b> Pringles Fresh Apple <b>Crystal Light</b></p>	<p><b>Lunch</b> Garden Salad with <b>Dressing</b> <b>Morningstar “Italian Sausage”</b> and <b>Pasta Carbanero</b> Mixed Fruit Cup <b>Crystal Light</b></p>
<p><b>Snack</b> <b>Reese Pieces</b> <b>Crystal Light</b></p>	<p><b>Snack</b> Quaker Oats Granola Bar Diet Soda</p>	<p><b>Snack</b> Whole Grain Goldfish <b>Crystal Light</b></p>	<p><b>Snack</b> 100 kcal Nabisco Peanut Butter Cookie Crisps Diet Soda</p>	<p><b>Snack</b> Quaker Oats Granola Bar <b>Crystal Light</b></p>	<p><b>Snack</b> <b>Reese Pieces</b> Diet Soda</p>	<p><b>Snack</b> Whole Grain Goldfish Diet Soda</p>
<p><b>Dinner</b> Garden Salad with <b>Dressing</b> <b>Lightlife Chick’n Cutlet</b> Candied Sweet Potatoes with <b>Mini Marshmallows</b> Green Peas Dinner Roll with <b>Margarine</b> Fruited Gelatin with Whipped Topping Ice Tea</p>	<p><b>Dinner</b> Southwestern <b>Lightlife “Steak Strips”</b> Salad with Lettuce, Tomato, Salsa, and <b>Edamame Fritos</b> Mandarin Oranges Frozen Fruit Bar Ice Tea</p>	<p><b>Dinner</b> <b>Boca Classic Burger Pattie</b> Mashed Potatoes with Gravy Carrots Dinner Roll with <b>Margarine</b> Lemon Cake with <b>Fruit Topping</b> Ice Tea</p>	<p><b>Dinner</b> Caesar Salad with Dressing <b>Spaghetti &amp; Morningstar Sausage Crumbles Sauce</b> Garlic Toast Fresh Grapes Lemon Sorbet Ice Tea</p>	<p><b>Dinner</b> <b>Lightlife Chick’n Cutlet</b> Roasted Red Potatoes Broccoli, Cauliflower &amp; Carrots in Cheese Sauce Dinner Roll with <b>Margarine</b> <b>Apple Crisp</b> Ice Tea</p>	<p><b>Dinner</b> <b>Boca Classic Burger Pattie</b> <b>Barbeque Sauce</b> Mashed Potatoes <b>Three Bean Salad</b> Vanilla Ice Cream with <b>Fruit Topping</b> Ice Tea</p>	<p><b>Dinner</b> Asian <b>Lightlife “Steak Strips”</b> Stir fry with <b>Edamame</b> Brown Rice Pineapple Pecan Sandies Ice Tea</p>
<p><b>Snack</b> Klondike Slim-a-Bear Ice Cream Sandwich Water</p>	<p><b>Snack</b> 100 kcal Jell-O Pudding Water</p>	<p><b>Snack</b> Smartfood Cheese Popcorn Diet Soda</p>	<p><b>Snack</b> Klondike Slim-a-Bear Ice Cream Sandwich Water</p>	<p><b>Snack</b> 100 kcal Jell-O Pudding Water</p>	<p><b>Snack</b> Smartfood Cheese Popcorn Diet Soda</p>	<p><b>Snack</b> 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><b>Breakfast</b> Grapefruit Half <b>Southwestern Cheese Omelet</b> <b>Morningstar Organic Breakfast Pattie</b> Toast with <b>Jam</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> Fresh Grapes Strawberry Yogurt with <b>Granola</b> Light Orange Juice Coffee</p>	<p><b>Breakfast</b> Banana Special K w/Skim Milk <b>Blueberry Muffin</b> <b>Morningstar Organic Breakfast Pattie</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> <b>Blueberries</b> <b>Pancakes</b> with Diet Syrup <b>Morningstar Organic Breakfast Pattie</b> Skim Milk Coffee</p>	<p><b>Breakfast</b> Grapefruit Half Scrambled Eggs <b>Morningstar Organic Breakfast Pattie</b> English Muffin with <b>Jam</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> Banana Bagel with <b>Cream Cheese</b> <b>Morningstar Organic Breakfast Pattie</b> Light Orange Juice Skim Milk Coffee</p>	<p><b>Breakfast</b> <b>Blueberries</b> Waffles with Diet Syrup <b>Morningstar Organic Breakfast Pattie</b> Skim Milk Coffee</p>
<p><b>Lunch</b> Tofurky “Philly Steak” Sandwich with Cheese, Lettuce &amp; Tomato, <b>Mayonnaise</b> Pringles Diced Pears Diet Soda</p>	<p><b>Lunch</b> <b>Spinach &amp; Morningstar Sausage Crumbles</b> <b>Quiche</b> Fresh Baby Carrots with <b>Vegetable Dip</b> Fresh Apple <b>Crystal Light</b></p>	<p><b>Lunch</b> Chef Salad with <b>Dressing</b> (Tofurky “Hickory Smoked”, Cheese, &amp; Egg) Melba Rounds Mixed Fruit Cup Diet Soda</p>	<p><b>Lunch</b> Tofurky “Italian” Sandwich with Cheese, Lettuce &amp; Tomato, <b>Mayonnaise</b> Harvest Cheddar Sun Chips Sugar Free Gelatin <b>Crystal Light</b></p>	<p><b>Lunch</b> Soft Taco with <b>Morningstar Sausage Crumbles</b> with Lettuce, Tomato, &amp; Cheese <b>Chips &amp; Salsa</b> Frozen Fruit Bar Diet Soda</p>	<p><b>Lunch</b> Cream of Tomato Soup Grilled Tofurky “Hickory Smoked” &amp; Cheese Sandwich Fresh Celery Sticks with <b>Vegetable Dip</b> Pringles Sugar Free Gelatin <b>Crystal Light</b></p>	<p><b>Lunch</b> Garden Salad with <b>Dressing</b> <b>Morningstar “Italian Sausage” &amp; Pasta Carbanero</b> Mixed Fruit Cup <b>Crystal Light</b></p>
<p><b>Snack</b> Peanut Goobers <b>Crystal Light</b></p>	<p><b>Snack</b> <b>Homemade Granola</b> Diet Soda</p>	<p><b>Snack</b> Cheese Twist Crackers <b>Crystal Light</b></p>	<p><b>Snack</b> Kroger Traditional Chex Mix Diet Soda</p>	<p><b>Snack</b> <b>Homemade Granola</b> <b>Crystal Light</b></p>	<p><b>Snack</b> Peanut Goobers Diet Soda</p>	<p><b>Snack</b> Cheese Twist Crackers Diet Soda</p>
<p><b>Dinner</b> Garden Salad with <b>Dressing</b> <b>Lightlife Chick’n Cutlet</b> Candied Sweet Potatoes with <b>Mini Marshmallows</b> Green Peas Dinner Roll with <b>Margarine</b> Sugar Free Gelatin with Whipped Topping Ice Tea</p>	<p><b>Dinner</b> Southwestern <b>Lightlife “Steak Strips”</b> Salad with Lettuce, Cheese, Salsa <b>Ranch Dressing, and Edamame</b> <b>Fritos</b> Mandarin Oranges Frozen Fruit Bar Ice Tea</p>	<p><b>Dinner</b> <b>Boca Classic Burger Pattie</b> Sautéed Mushrooms Mashed Potatoes with Gravy Broccoli Dinner Roll with <b>Margarine</b> <b>Angel Food Cake with Fruit Topping</b> Ice Tea</p>	<p><b>Dinner</b> Caesar Salad with <b>Dressing</b> <b>Spaghetti &amp; Morningstar Sausage Crumbles Sauce</b> Green Beans Garlic Toast Lemon Sorbet Ice Tea</p>	<p><b>Dinner</b> <b>Lightlife Chick’n Cutlet</b> Roasted Red Potatoes Broccoli, Cauliflower &amp; Carrots in Cheese Sauce Dinner Roll <b>Apple Crisp</b> Ice Tea</p>	<p><b>Dinner</b> <b>Boca Classic Burger Pattie</b> <b>Barbeque Sauce</b> Mashed Potatoes <b>Three Bean Salad</b> Dinner Roll with <b>Margarine</b> Vanilla Ice Cream with <b>Fruit Topping</b> Ice Tea</p>	<p><b>Dinner</b> Asian <b>Lightlife “Steak Strips”</b> Stir fry with <b>Edamame</b> Soba Noodles Fresh Pineapple Peanut Butter Cookie Crisps Ice Tea</p>
<p><b>Snack</b> Skinny Cow Truffle Bar Water</p>	<p><b>Snack</b> <b>Sugar Free Jell-O Pudding</b> Water</p>	<p><b>Snack</b> Microwave Popcorn Diet Soda</p>	<p><b>Snack</b> Skinny Cow Truffle Bar Water</p>	<p><b>Snack</b> <b>Sugar Free Jell-O Pudding</b> Water</p>	<p><b>Snack</b> Microwave Popcorn Diet Soda</p>	<p><b>Snack</b> <b>Sugar Free Jell-O Pudding</b> 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><b>Breakfast</b> Grapefruit Sections <b>Southwestern Scrambled Eggs with Cheese</b> <b>Morningstar Organic Breakfast Pattie</b> Whole Wheat Toast &amp; <b>Jam</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> Yogurt with <b>Almonds, Wheat Germ &amp; Cranberries</b> <b>Naked Very Berry Juice</b> Coffee</p>	<p><b>Breakfast</b> <b>Melon Balls</b> Cottage Cheese with <b>Jam</b> <b>Blueberry Muffin Morningstar Organic Breakfast Pattie</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> Raspberries with Yogurt <b>Pancakes with Diet Syrup</b> <b>Morningstar Organic Breakfast Pattie</b> <b>Naked Very Berry Juice</b> Coffee</p>	<p><b>Breakfast</b> Grapefruit Sections <b>Southwestern Scrambled Eggs with Cheese</b> <b>Morningstar Organic Breakfast Pattie</b> <b>English Muffin &amp; Jam</b> Cranberry Beverage Coffee</p>	<p><b>Breakfast</b> Yogurt with <b>Almonds, Wheat Germ &amp; Cranberries</b> <b>Naked Very Berry Juice</b> Coffee</p>	<p><b>Breakfast</b> Raspberries with Yogurt <b>Pancakes with Diet Syrup</b> <b>Morningstar Organic Breakfast Pattie</b> <b>Naked Very Berry Juice</b> Coffee</p>
<p><b>Lunch</b> Tofurky “Philly Steak” Wrap with Lettuce, Spinach, Red Pepper, Cheese &amp; Tomato <b>Light Ranch Dressing Pretzels</b> <b>Naked Very Berry Juice</b> Diet Soda</p>	<p><b>Lunch</b> <b>Spinach &amp; Morningstar Sausage Crumbles Quiche</b> Fresh Baby Carrots with <b>Vegetable Dip</b> Cottage Cheese &amp; Peaches <b>Crystal Light</b></p>	<p><b>Lunch</b> Garden Vegetable Soup Chef Salad with <b>Dressing (Tofurky “Hickory Smoked”, Cheese, Soynuts, and Egg)</b> Sesame Crackers Sugar Free Gelatin Diet Soda</p>	<p><b>Lunch</b> Tofurky “Italian” Wrap with Lettuce, Spinach, Red Pepper, Cheese &amp; Tomato <b>Light Ranch Dressing Pretzels</b> <b>Crystal Light</b></p>	<p><b>Lunch</b> <b>Morningstar Sausage Crumbles Fajita Salad</b> <b>Chips &amp; Salsa</b> Mandarin Oranges Diet Soda</p>	<p><b>Lunch</b> Cream of Tomato Soup Grilled Tofurky “Hickory Smoked Sandwich Fresh Celery Sticks with <b>Vegetable Dip</b> Sugar Free Gelatin <b>Crystal Light</b></p>	<p><b>Lunch</b> Spinach Salad with <b>Dressing and Soynuts</b> <b>Morningstar “Italian Sausage” &amp; Pasta Primavera</b> <b>Crystal Light</b></p>
<p><b>Snack</b> Cheese and Crackers <b>Crystal Light</b></p>	<p><b>Snack</b> <b>Homemade Granola</b> Diet Soda</p>	<p><b>Snack</b> <b>Pumpkin Seed Crackers</b> <b>Crystal Light</b></p>	<p><b>Snack</b> <b>Pasta Chips</b> Diet Soda</p>	<p><b>Snack</b> <b>Homemade Granola</b> <b>Crystal Light</b></p>	<p><b>Snack</b> Cheese and Crackers Diet Soda</p>	<p><b>Snack</b> <b>Pumpkin Seed Crackers</b> Diet Soda</p>
<p><b>Dinner</b> Garden Salad with <b>Dressing and Soynuts</b> <b>Lightlife Chick’n Cutlet</b> Candied Sweet Potatoes with <b>Mini Marshmallows</b> Asparagus Whole Wheat Bread with <b>Margarine</b> Sugar Free Gelatin with Whipped Topping Ice Tea</p>	<p><b>Dinner</b> <b>Southwestern Lightlife “Steak Strips” Salad</b> with Lettuce, Spinach, Cheese <b>Edamame &amp; Salsa</b> <b>Fritos</b> Mandarin Oranges Ice Tea</p>	<p><b>Dinner</b> <b>Boca Classic Burger Pattie</b> Sautéed Mushrooms Mashed Potatoes with Gravy Broccoli Spears Whole Wheat Bread with <b>Margarine</b> <b>Angel Food Cake</b> Ice Tea</p>	<p><b>Dinner</b> Caesar Salad with Dressing <b>Spaghetti &amp; Morningstar Sausage Crumbles Sauce</b> Brussels Sprouts <b>Melon Balls</b> Ice Tea</p>	<p><b>Dinner</b> <b>Lightlife Chick’n Cutlet</b> Parmesan Red Potatoes Broccoli, Cauliflower &amp; Carrots w/ Cheese Sauce Whole Wheat Bread Pineapple Chunks Ice Tea</p>	<p><b>Dinner</b> <b>Boca Classic Burger Pattie</b> <b>Barbeque Sauce</b> Mashed Potatoes Brussels Sprouts Whole Wheat Bread with <b>Margarine</b> Vanilla Ice Cream Ice Tea</p>	<p><b>Dinner</b> Asian Lightlife “Steak Strips” Stir fry with <b>Edamame</b> Soba Noodles Pineapple Chunks <b>Sugar Free Shortbread Cookie</b> Ice Tea</p>
<p><b>Snack</b> Frozen Fruit Smoothie Water</p>	<p><b>Snack</b> <b>Sugar Free Jell-O Pudding</b> Water</p>	<p><b>Snack</b> <b>Cheesy Herb Popcorn</b> Diet Soda</p>	<p><b>Snack</b> Frozen Fruit Smoothie Water</p>	<p><b>Snack</b> <b>Sugar Free Jell-O Pudding</b> Water</p>	<p><b>Snack</b> <b>Cheesy Herb Popcorn</b> Diet Soda</p>	<p><b>Snack</b> <b>Sugar Free Jell-O Pudding</b> 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><b><i>Breakfast</i></b>                      Tropical Fruit Salad                      Western Omelet with  <b>Canadian Bacon</b> &amp; Cheese                      Toast with Margarine &amp; Jam                      Capri Sun - Sunrise                      Coffee</p>	<p><b><i>Breakfast</i></b>                      Cantaloupe &amp; Honeydew Melon                      Lemon Poppyseed Muffin                      Fruited Yogurt                      Apple Juice                      Coffee</p>	<p><b><i>Breakfast</i></b>  <b>Ham</b> &amp; Cheese Biscuit                      Potatoes O'Brien                      Capri Sun – Tropical Fruit                      Coffee</p>
<p><b><i>Lunch</i></b>                      Mini Chef Salad with Dressing  <b>Ham</b> &amp; Cheese Pizza                      Fruit Snack                      Diet Soda</p>	<p><b><i>Lunch</i></b>                      Cream of Broccoli Soup  <b>Ham Salad</b> on                      Whole Wheat Crackers                      Fresh Apple                      Raisins                      Crystal Light</p>	<p><b><i>Lunch</i></b>  <b>Beef &amp; Cheese Enchilada</b>                      Chips &amp; Salsa                      Fresh Grapes                      Diet Soda</p>
<p><b><i>Snack</i></b>                      Yogurt Covered Raisins                      Crystal Light</p>	<p><b><i>Snack</i></b>                      Hershey Almond Nuggets                      Diet Soda</p>	<p><b><i>Snack</i></b>                      Pretzels with Cheese Dip                      Crystal Light</p>
<p><b><i>Dinner</i></b>  <b>Beef Stroganoff</b>                      Broccoli Spears                      Dinner Roll with Margarine                      Peach Crisp                      Ice Tea</p>	<p><b><i>Dinner</i></b>  <b>Salisbury Steak &amp; Gravy</b>                      Mashed Potatoes                      Green Beans                      Pineapple Upside down Cake                      Ice Tea</p>	<p><b><i>Dinner</i></b>  <b>Asian Pork Stir fry</b>                      Brown Rice                      Mandarin Oranges                      Gingersnap Cookies                      Ice Tea</p>
<p><b><i>Snack</i></b>                      Pears with Cottage Cheese                      Water</p>	<p><b><i>Snack</i></b>                      Caramel Flavored Rice Cakes                      Diet Soda</p>	<p><b><i>Snack</i></b>                      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><b><i>Breakfast</i></b> Tropical Fruit Salad Western Omelet with <b>Canadian Bacon</b> &amp; Cheese Toast with Jam Capri Sun - Sunrise Coffee</p>	<p><b><i>Breakfast</i></b> Cantaloupe &amp; Honeydew Melon Lemon Poppyseed Muffin Fruited Yogurt Light Orange Juice Coffee</p>	<p><b><i>Breakfast</i></b> <b>Ham</b> &amp; Cheese Biscuit Potatoes O'Brien Capri Sun – Tropical Fruit Coffee</p>
<p><b><i>Lunch</i></b> Mini Chef Salad with Dressing <b>Ham</b>, Mushroom &amp; Cheese Pizza Fruit Snack Diet Soda</p>	<p><b><i>Lunch</i></b> Cream of Broccoli Soup <b>Ham Salad</b> on Flatbread Crisps Fresh Apple Crystal Light</p>	<p><b><i>Lunch</i></b> <b>Beef &amp; Cheese Enchilada</b> Chips &amp; Salsa Fresh Grapes Diet Soda</p>
<p><b><i>Snack</i></b> Pretzels with Ranch Dip Crystal Light</p>	<p><b><i>Snack</i></b> Cinnamon Brown Sugar Almonds Diet Soda</p>	<p><b><i>Snack</i></b> Homemade Granola Crystal Light</p>
<p><b><i>Dinner</i></b> <b>Beef Stroganoff</b> Broccoli Spears Dinner Roll with Margarine Peach Crisp Ice Tea</p>	<p><b><i>Dinner</i></b> <b>Salisbury Steak &amp; Gravy</b> Mashed Potatoes Green Beans Almondine Dinner Roll Pineapple Upside down Cake Ice Tea</p>	<p><b><i>Dinner</i></b> <b>Asian Pork Stir fry</b> Soba Noodles Mandarin Oranges Gingersnap Cookies Ice Tea</p>
<p><b><i>Snack</i></b> Pears with Cottage Cheese Water</p>	<p><b><i>Snack</i></b> Cheesy Herb Popcorn Diet Soda</p>	<p><b><i>Snack</i></b> 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><b><i>Breakfast</i></b> Tropical Fruit Salad Western Omelet with <b>Canadian Bacon</b> &amp; Cheese Toast with Jam V8 Juice Coffee</p>	<p><b><i>Breakfast</i></b> Blackberries Lemon Poppyseed Muffin Fruited Yogurt with Wheat Germ Carrotty Orange Juice Coffee</p>	<p><b><i>Breakfast</i></b> <b>Ham</b> &amp; Cheese Biscuit Potatoes O'Brien Naked Very Berry Juice Coffee</p>
<p><b><i>Lunch</i></b> Mini Chef Salad with Dressing <b>Ham</b>, Mushroom &amp; Cheese Pizza Sugar Free Gelatin Diet Soda</p>	<p><b><i>Lunch</i></b> Cream of Broccoli Soup <b>Ham Sandwich</b> with Lettuce, Cheese, Tomato and Mustard Crystal Light</p>	<p><b><i>Lunch</i></b> <b>Beef &amp; Cheese Enchilada</b> Chips &amp; Salsa Sugar Free Gelatin Diet Soda</p>
<p><b><i>Snack</i></b> Pretzels with Ranch Dip Crystal Light</p>	<p><b><i>Snack</i></b> Cheesy Herb Popcorn Diet Soda</p>	<p><b><i>Snack</i></b> Homemade Granola Crystal Light</p>
<p><b><i>Dinner</i></b> <b>Beef Stroganoff</b> Asparagus Spears Whole Wheat Bread with Margarine Peach Crisp Ice Tea</p>	<p><b><i>Dinner</i></b> <b>Salisbury Steak &amp; Gravy</b> Mashed Potatoes Green Beans Almondine Whole Wheat Bread Pineapple Chunks Ice Tea</p>	<p><b><i>Dinner</i></b> <b>Asian Pork Stir fry</b> Soba Noodles Mandarin Oranges Ice Tea</p>
<p><b><i>Snack</i></b> Pears with Cottage Cheese Water</p>	<p><b><i>Snack</i></b> Frozen Smoothie Diet Soda</p>	<p><b><i>Snack</i></b> Chocolate Mousse Water</p>



## Soy & Legume – 10% Protein Menu

<i>Day 25</i>	<i>Day 26</i>	<i>Day 27</i>
<p><b><i>Breakfast</i></b> Tropical Fruit Salad Western Omelet with Cheese &amp; <b>Morningstar Sausage Crumbles</b> Toast with Margarine &amp; Jam Capri Sun - Sunrise Coffee</p>	<p><b><i>Breakfast</i></b> Cantaloupe &amp; Honeydew Melon Lemon Poppyseed Muffin Fruited Yogurt Apple Juice Coffee</p>	<p><b><i>Breakfast</i></b> <b>Morningstar Organic Breakfast</b> <b>Pattie &amp; Cheese Biscuit</b> Potatoes O'Brien Capri Sun – Tropical Fruit Coffee</p>
<p><b><i>Lunch</i></b> Mini Chef Salad with Dressing <b>Morningstar Italian Sausage</b> &amp; Cheese Pizza Fruit Snack Diet Soda</p>	<p><b><i>Lunch</i></b> Cream of Broccoli Soup <b>Red Pepper Hummus</b> on Pretzel Crisps Fresh Apple Raisins Crystal Light</p>	<p><b><i>Lunch</i></b> <b>Morningstar Sausage</b> <b>Crumbles &amp; Cheese Enchilada</b> Chips &amp; Salsa Fresh Grapes Diet Soda</p>
<p><b><i>Snack</i></b> Yogurt Covered Raisins Crystal Light</p>	<p><b><i>Snack</i></b> Mr. Goodbar Diet Soda</p>	<p><b><i>Snack</i></b> Pretzels with Cheese Dip Crystal Light</p>
<p><b><i>Dinner</i></b> <b>Lightlife “Steak Strips”</b> <b>Stroganoff</b> Broccoli Spears Dinner Roll with Margarine Peach Crisp Ice Tea</p>	<p><b><i>Dinner</i></b> <b>Boca Burger &amp; Gravy</b> Mashed Potatoes Green Beans Pineapple Upsidedown Cake Ice Tea</p>	<p><b><i>Dinner</i></b> <b>Asian “Steak Strips” Stir fry</b> Brown Rice Mandarin Oranges Gingersnaps Ice Tea</p>
<p><b><i>Snack</i></b> Pears with Cottage Cheese Water</p>	<p><b><i>Snack</i></b> Caramel Flavored Rice Cakes Diet Soda</p>	<p><b><i>Snack</i></b> 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><b><i>Breakfast</i></b> Tropical Fruit Salad Western Omelet with Cheese &amp; <b>Morningstar Sausage Crumbles</b> Toast with Jam Capri Sun - Sunrise Coffee</p>	<p><b><i>Breakfast</i></b> Cantaloupe &amp; Honeydew Melon Lemon Poppyseed Muffin Fruited Yogurt Light Orange Juice Coffee</p>	<p><b><i>Breakfast</i></b> <b>Morningstar Organic Breakfast</b> <b>Pattie</b> &amp; Cheese Biscuit Potatoes O'Brien Capri Sun – Tropical Fruit Coffee</p>
<p><b><i>Lunch</i></b> Mini Chef Salad with Dressing <b>Morningstar Italian Sausage,</b> Mushroom &amp; Cheese Pizza Fruit Snack Diet Soda</p>	<p><b><i>Lunch</i></b> Cream of Broccoli Soup <b>Red Pepper Hummus</b> on Flatbread Crisps Fresh Apple Crystal Light</p>	<p><b><i>Lunch</i></b> <b>Morningstar Sausage</b> <b>Crumbles</b> &amp; Cheese Enchilada Chips &amp; Salsa Fresh Grapes Diet Soda</p>
<p><b><i>Snack</i></b> Pretzels with Ranch Dip Crystal Light</p>	<p><b><i>Snack</i></b> Cinnamon Brown Sugar Almonds Diet Soda</p>	<p><b><i>Snack</i></b> Homemade Granola Crystal Light</p>
<p><b><i>Dinner</i></b> <b>Lightlife “Steak Strips”</b> <b>Stroganoff</b> Broccoli Spears Dinner Roll with Margarine Peach Crisp Ice Tea</p>	<p><b><i>Dinner</i></b> <b>Boca Burger &amp; Gravy</b> Mashed Potatoes Green Beans Almondine Dinner Roll Pineapple Upsidedown Cake Ice Tea</p>	<p><b><i>Dinner</i></b> <b>Asian “Steak Strips” Stir fry</b> Soba Noodles Mandarin Oranges Gingersnaps Ice Tea</p>
<p><b><i>Snack</i></b> Pears with Cottage Cheese Water</p>	<p><b><i>Snack</i></b> Cheesy Herb Popcorn Diet Soda</p>	<p><b><i>Snack</i></b> 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><b><i>Breakfast</i></b>  Tropical Fruit Salad  Western Omelet with Cheese &amp;  <b>Morningstar Sausage Crumbles</b>  Toast with Jam  V8 Juice  Coffee</p>	<p><b><i>Breakfast</i></b>  Blackberries  Lemon Poppyseed Muffin  Fruited Yogurt with Wheat Germ  Carrotty Orange Juice  Coffee</p>	<p><b><i>Breakfast</i></b>  Open Face <b>Morningstar Organic  Breakfast Pattie &amp; Cheese Biscuit</b>  Potatoes O'Brien  Naked Very Berry Juice  Coffee</p>
<p style="text-align: center;"><b><i>Lunch</i></b></p> <p>Mini Chef Salad with Dressing  <b>Morningstar Italian Sausage,</b>  Mushroom &amp; Cheese Pizza  Sugar Free Gelatin  Diet Soda</p>	<p style="text-align: center;"><b><i>Lunch</i></b></p> <p>Cream of Broccoli Soup  <b>Tofurky “Hickory Smoked  Sandwich</b> with Lettuce, Cheese,  Tomato and Mustard  Crystal Light</p>	<p style="text-align: center;"><b><i>Lunch</i></b></p> <p><b>Morningstar Sausage  Crumbles &amp; Cheese Enchilada</b>  Chips &amp; Salsa  Sugar Free Gelatin  Diet Soda</p>
<p style="text-align: center;"><b><i>Snack</i></b></p> <p>Pretzels with Ranch Dip  Crystal Light</p>	<p style="text-align: center;"><b><i>Snack</i></b></p> <p>Cheesy Herb Popcorn  Diet Soda</p>	<p style="text-align: center;"><b><i>Snack</i></b></p> <p>Homemade Granola  Crystal Light</p>
<p style="text-align: center;"><b><i>Dinner</i></b></p> <p><b>Lightlife “Steak Strips”  Stroganoff</b>  Asparagus Spears  Whole Wheat Bread with  Margarine  Peach Crisp  Ice Tea</p>	<p style="text-align: center;"><b><i>Dinner</i></b></p> <p><b>Boca Burger &amp; Gravy</b>  Mashed Potatoes  Green Beans Almondine  Whole Wheat Bread  Pineapple Chunks  Ice Tea</p>	<p style="text-align: center;"><b><i>Dinner</i></b></p> <p><b>Asian “Steak Strips” Stir fry</b>  Soba Noodles  Mandarin Oranges  Ice Tea</p>
<p style="text-align: center;"><b><i>Snack</i></b></p> <p>Pears with Cottage Cheese  Water</p>	<p style="text-align: center;"><b><i>Snack</i></b></p> <p>Frozen Smoothie  Diet Soda</p>	<p style="text-align: center;"><b><i>Snack</i></b></p> <p>Chocolate Mousse  Water</p>

**Appendix 3: Test Day Menu – All Subjects**

**Breakfast**

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

Fresh Red Grapes

English M<sup>c</sup>Campbell

(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