



Health Connections

LINKING NUTRITION RESEARCH TO PRACTICE

DIETARY PROTEIN AND BRANCHED-CHAIN AMINO ACIDS: Important Roles in Blood Glucose Stability

INTRODUCTION

The escalating incidence of obesity has led to a concomitant rise in related health conditions such as high levels of blood glucose and insulin resistance. Intensive research has been conducted in an attempt to identify successful interventions to control these related disorders. The role of protein in weight control, food regulation and satiety¹ and the role of branched-chain amino acids (BCAAs) in blood glucose control² have been topics of recent interest. In this issue, *Health Connections* examines some research on the metabolic impact of increased protein and BCAA intake on weight loss, stabilization of blood glucose levels, and retention of lean body mass.

METABOLIC ROLES BEYOND MINIMUM REQUIREMENTS

Approaches to weight management continue to center around the fundamental concept of balancing energy intake and expenditure. The proposed Dietary Guidelines 2005 maintain that calories count.³ Many nutrition professionals use the Institute of Medicine's (IOM) Accepted Macronutrient Distribution Ranges (AMDR) to individualize dietary interventions based on energy balance to accommodate weight management goals and food preferences. AMDR percent of calories for fat is 20-35%; for carbohydrate 45-65% and for protein 10-35%. These ranges can also be used to distribute macronutrients in the diet to achieve *metabolic balance*, which considers the diversity of macronutrient functions in addition to providing energy.

In the diet, proteins provide the naturally occurring 20 amino acids, most importantly the 9 essential amino acids. In the body, proteins comprise the major structural components of all cells, function as enzymes and hormones and as transport carriers in membranes. Component amino

acids serve as precursors for nucleic acids, hormones, vitamins and other important molecules⁴ in addition to providing the basic substrates for protein synthesis. Protein from meat, poultry, fish, eggs, milk, cheese and yogurt provide all nine indispensable amino acids in ideal proportions and are referred to as "complete proteins."⁴ Based on nitrogen balance studies, the Recommended Dietary Allowance (RDA) for both genders is 0.80 grams of good quality protein per kilogram body weight per day.

Some experts believe the RDAs for branched-chain amino acids (BCAAs) are not sufficient to optimize metabolic roles beyond protein synthesis. The BCAAs differ from other amino acids in that they enter the systemic circulation where they have multiple metabolic functions. Leucine, for example, has a unique role in stimulating muscle protein synthesis during caloric restriction or after endurance exercise. In addition, leucine helps regulate blood glucose through the insulin signaling pathway. Dairy proteins are higher in BCAAs, particularly leucine, compared with meat or plant proteins. Whey, a by-product of cheese, is the highest natural source of BCAAs.⁵ Thus, **dietary patterns built around high quality protein may increase the amount of leucine, which may result in optimal lean body mass and better glycemic control.**

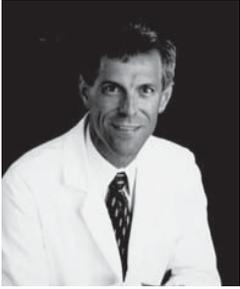
continued on page 2



Mary Jo Feeney, MS, RD, FADA

HEALTH CONNECTIONS EDITOR

Mary Jo Feeney specializes in nutrition communications and marketing. With over 30 years experience in public health nutrition and education, she currently is a leading consultant to the food, agriculture and health care industries. A charter Fellow of the American Dietetic Association, Mary Jo served on the Board of Directors of both the American Dietetic Association (ADA) and its Foundation (ADAF) and received the association's Medallion Award in 1996.



Donald K. Layman, Professor of Nutrition, University of Illinois Urbana-Champaign

METABOLIC RESPONSE TO A MODERATE PROTEIN INTAKE TARGETING BCAA

In an interview with Donald K. Layman, Professor of Nutrition, University of Illinois Urbana-Champaign, we further explore the expanding biological role of amino acids in weight management and blood glucose control. Dr. Layman has conducted research using diets that shift calories away from carbohydrate in favor of protein, specifically planned to increase leucine intake.

Q. What was the basis for the hypothesis that a moderate increase in dietary protein – with a corresponding lowering of carbohydrate – would stabilize blood glucose and insulin during weight loss?

A. Discussion around the prevention and treatment of obesity often centers on the optimal balance of macronutrients as energy sources – focusing primarily on carbohydrates and fat. However, some researchers have reported beneficial effects on body composition and blood lipids when protein is directly substituted for carbohydrate.⁶ Although a fundamental hypothesis explaining these benefits of protein was not established, it is known that protein plays a role in food regulation and satiety, functions distinct from the provision of energy.

We proposed that increasing the daily intake of protein to at least 120 grams (1.6 g/kg body weight) and lowering carbohydrate intake to 150 g or less would maximize the benefits of leucine in maintaining body composition and help to stabilize blood levels of glucose and insulin. Our approach provides a rationale for developing dietary recommendations using the DRI concept of acceptable ranges for protein based on *desired metabolic outcomes* rather than on caloric contribution.²

We found that a higher protein diet stabilized blood glucose during non-absorptive periods and reduced postprandial insulin response. In addition, while the weight loss between the groups was similar, the higher protein diet partitioned a greater percentage of the weight loss to body fat, while sparing lean tissue.⁷

Q. What is the mechanism thought responsible for the improved blood glucose control and weight management on higher protein diets?

A: Because the brain relies on a constant supply of blood glucose for fuel, the body has a complex system to maintain stable blood glucose levels. This system can be simplified to two components – a peripheral system using insulin to regulate disposal of dietary glucose into muscle and fat tissues, and a central system using the liver to regulate the appearance of glucose into the blood. Diets

high in carbohydrates rely on insulin and the peripheral system to manage large changes in blood glucose levels. Diets higher in protein and lower in carbohydrate, on the other hand, draw upon the liver to manage blood glucose, preventing large swings in glucose and insulin levels and resulting in more constant levels.

The weight management benefit of higher protein diets is in part due to these more constant glucose and insulin levels, which spare some individuals the “constantly hungry” feeling experienced on high carbohydrate diets.

Q. With the increasing incidence of obesity and pre-diabetes in this country, do you think there will be more emphasis on protein intake for adult health?

A: Yes. There is currently a huge amount of attention to the quantity and quality of carbohydrates in the diet. Food recommendations and diet plans often start with carbohydrate and then add protein and fat as “fill ins.” **It is important to not add protein or fat by default but to evaluate and change the diet macronutrient distribution for specific metabolic purposes.** Increasing dietary protein can help with energy intake by increasing satiety, improving body composition, and stabilizing metabolism. Some diets reduce carbohydrates and increase fat intake by default. We need to remember that dietary fat is a major source of calories and we still need to manage fat intake carefully for weight control.

Q. The Dietary Guidelines 2005 have a strong physical activity recommendation. What role does protein – specifically leucine – play in physical activity and thus weight loss?

A. Early research on leucine focused on its role in maintaining muscle protein during periods of starvation. BCAAs are unique in that they help minimize muscle wasting under conditions of protein breakdown. When you think about protein as it relates to obesity, you want to lose fat, not lean body mass. Protein helps spare muscle, resulting in better body composition. Since muscle burns more fuel, a higher proportion of lean tissue will help achieve greater long-term weight loss and maintenance of that weight loss. Even adults

REFERENCES

¹Anderson GH, Moore SE. J Nutr 2004; 134: 974S-979S.

²Layman DK. J Nutr 2003; 133: 261S-267S.

³Dietary Guidelines Advisory Committee Report, 2005. Available at: http://www.health.gov/dietaryguidelines/dga2005/report/PDF/D2_Energy.pdf.

⁴Institute of Medicine 2002. Dietary Reference Intakes Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. The National Academies Press, Washington, DC 2001. www.nap.edu.

⁵Dairy Council Digest. Emerging Health Benefits of Whey. National Dairy Council. www.nationaldairy.org/health/digest.

⁶Piatti PM, et al. Metab 1994; 43: 1481-1487.

⁷Layman DK. J Nutr 2003; 133: 411-417.

OTHER RESOURCES

Layman DK, Baum JI. J Nutr 2004; 134: 968S-973S.
Layman DK et al. J Nutr 2003; 133: 405-410.

who choose to be sedentary need protein to maintain their muscle structure.

Q. What is the reason for developing diets calculating protein based on body weight – as you've done in your studies – rather than as a percent of calories consumed?

A. We really do not know the ideal protein intake for adults, especially adults with sedentary lifestyles and exposed to too many calories. However, we are reasonably convinced that the optimal metabolic effects of leucine require a daily total protein of at least 120 g/day. For individuals within "reasonable" weight ranges a factor of 1.6 g protein/kg body weight/day works. Obviously, for individuals who are extremely heavy or extremely light the factor is more difficult to apply.

As you reduce calories for weight loss, protein need does not decrease as implied by determining intake using percent of calories. Each time you change the calorie level, you change the protein level and as the calories get reduced, you risk becoming protein deficient. For example, on a 1400 calorie diet with 12 percent calories from protein, protein intake is only 42 grams. I suggest we change our way of thinking as to where to start – set protein at the target based on weight (for example, 1.6 g/kg), set fat intake within health guidelines, and lower the carbohydrate-to-protein ratio to less than 2. (See sample calculation and food pattern.)

Q. What suggestions do you have for health professionals working with clients who are overweight and insulin resistant?

A. The goal is to get the right person on the right diet. We now know that a higher protein, lower carbohydrate diet is healthy and effective for

weight loss. The DRI concept of ranges as guidelines offers the opportunity to create healthy diets with different macronutrient combinations. This gives health professionals another tool and greater flexibility for developing nutrition strategies for long-term health – particularly when working with individuals for whom a particular, perhaps more traditional, approach based on macronutrient distribution by percent of calories isn't working.

CALCULATION AND FOOD PATTERN

Sample calculation and food pattern for a mid-life sedentary female who weighs 180 pounds (82 kg). The pattern is based on 1.6 g high quality protein/kg body weight and is within AMDR guidelines (adapted from ref 7).

- Calculate protein need: $82 \text{ kg} \times 1.6\text{g/kg} = 131\text{g}$ or 525 kcal.
- Determine calorie level: 1700 kcals (based on basal metabolic rate plus activity factor).
- Set fat level within AMDR guideline of 10-35% of calories, e.g. 23% of 1700 kcal = 391 kcal or 43g fat.
- Determine calories remaining to be allocated to carbohydrate: $1700 - 525 - 391 = 784$ calories or 196 g.
- Verify carbohydrates are within AMDR guideline of 45-65% of calories: $784/1700 = 46\%$; and protein within AMDR guidelines of 10-35% calories: $525/1700 = 31\%$.
- Confirm that carbohydrate:protein ratio is below 2.0: $196\text{g}/131\text{g} = 1.5$.

Sample basic food pattern (individualized according to client preferences):

- 3 servings of low-fat dairy
- 9-10 ounces of lean animal protein
- 5-6 servings of vegetables
- 2 servings of fruit
- 4 servings of grains/pasta/rice

PRACTICE POINTS FOR THE HEALTH PROFESSIONAL

- Stay abreast of research on the effect of a high-protein low-carbohydrate diet on blood glucose control in borderline or diagnosed type 2 diabetes.
- Consider recommending a diet higher in protein and lower in carbohydrate, within appropriate ranges, to certain clients to facilitate blood glucose control and weight management. Pay particular attention to BCAAs for their emerging roles in glucose stability and weight management.
- Use macronutrient ranges as guidelines. Successful interventions to prevent or manage weight gain will be as varied as the individuals who seek them.
- Take advantage of the Dietary Guidelines' 2005 emphasis on the need for physical activity. Discuss the role of high quality protein in stimulating muscle protein synthesis and maintaining muscle during weight loss – important to help the body burn calories.
- Remember that although a calorie is a calorie in terms of weight management, a certain ratio of macronutrients may optimize metabolic parameters such as blood glucose and insulin levels, making it easier to control hunger, positively impacting body composition, and helping in weight maintenance.