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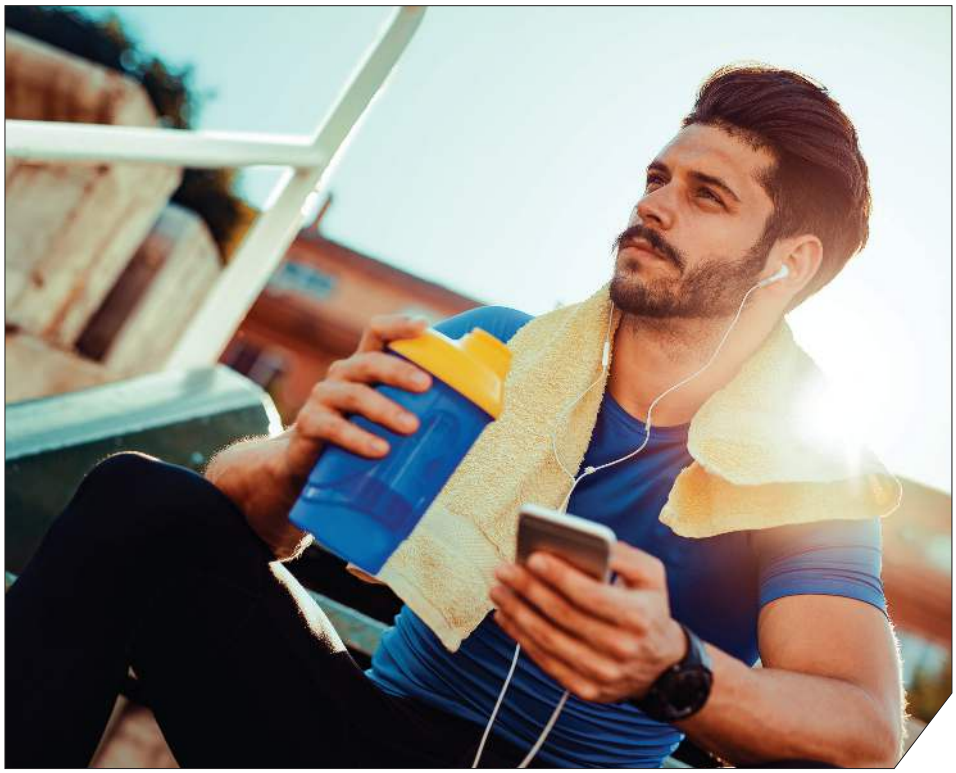
Performance nutrition: plant versus animal proteins



EDITORIAL

With dietary trends and the availability of nutrition information evolving each year, dietitians and those working in the food industry are relied upon to provide expert opinions on the latest scientific knowledge and appropriate advice regarding novel products.

The surge of veganism and plant-based eating is one of the dominant trends in recent months and is set to rise. With this, performance nutrition is also adapting and some athletes are seeking alternatives to traditional animal-based protein sources. In this edition, Performance Nutritionist, Dr Catherine Norton will explore the area of plant and animal proteins for exercise recovery and review the efficacy of both.

We hope you enjoy this edition of *DN Forum* and look forward to any feedback or comments you wish to share: nutrition@ndc.ie

Marianne Walsh

Dr Marianne Walsh
Nutrition Manager
The National Dairy Council (NDC)

Summary points

- Muscle recovery following exercise is particularly important for optimising the benefits of training and subsequent sports performance. It is generally accepted that the consumption of 15-25g of protein within one hour following an intense exercise session supports optimal muscle recovery.
- The amino-acid composition of a protein and, more specifically, its leucine content has been identified as a key independent predictor of its capacity to stimulate muscle-protein synthesis. Milk and whey are rich in leucine and are, therefore, popular choices following exercise.
- A trend towards plant-based diets has led to many consumers and athletes seeking alternatives to traditional animal-based protein sources.
- Plant and animal-based proteins differ in terms of their amino-acid composition, which impacts digestibility and biological value. The greater biological value of animal-based proteins is mainly due to the presence of all essential amino acids (EAAs), whereas plant-based proteins often lack one or more EAAs. Theoretically, different plant sources could be combined to overcome this issue and provide the full complement of EAAs. However, at present, there is a lack clinical evidence to support the efficacy of plant proteins, on their own or in combination, for optimal recovery following exercise.
- Factors such as antinutritional compounds present in plant foods have been shown to interfere with amino acid digestion, absorption and availability for the stimulation of muscle-protein synthesis. Therefore, for those athletes that are embarking on a plant-based diet, it would be prudent to consume larger quantities of plant protein (towards the upper end of the recommendations), in order to compensate for their lower biological value. Also, plant protein sources should be combined to ensure no EAAs are limited.
- Additional supplementation with micronutrients, such as vitamin B12 may be necessary, as replacement of protein alone will not negate the losses of other important nutrients present in animal foods.

Sports performance and recovery from exercise – are all proteins equal?

Dr Catherine Norton

Dr Catherine Norton RD, rSEN, PhD
Health Research Institute, University of Limerick
Co-Principal Investigator, Food for Health Ireland, Healthy Ageing & Performance Nutrition Programme

Introduction

Nutrition has an irrefutable role in the support of athletic training. Through the assessment of specific factors (summarised in Figure 1), sports and exercise nutritionists can determine optimal nutritional strategies to support specific training requirements for competitive events. As exercise elicits an array of physiological responses in the body, the recovery phase following exercise is particularly important in optimising the benefits of training and subsequent performance at the next exercise session.

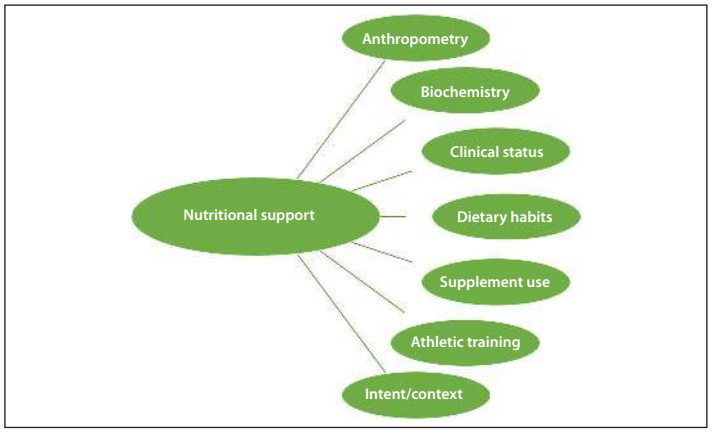


Figure 1.

In the context of resistance exercise, the beneficial role of protein in facilitating the accrual of lean tissue mass is unequivocal in the extant literature[1-6]. Succinctly, optimising protein quantity, timing and quality, in combination with a resistance training stimulus, supports the optimal accrual of lean tissue mass[7]. It is generally accepted that the consumption of 15-25g of protein within one hour following an intense exercise session is sufficient to support optimal muscle recovery[8, 9]. In addition, the amino acid composition and, more specifically, the leucine content of the protein has been identified as a key independent predictor of its capacity to stimulate muscle protein synthesis[10, 11]. However, there is a lack of consensus regarding the nuances of optimal protein ingestion relative to individual preferences, needs and training loads. Research is ongoing to determine the most appropriate protein choices and delivery approaches in optimising lean-mass accrual.

Meat, fish, chicken and dairy are the primary protein-providing foods among Irish adults[12]. Due to its leucine-rich whey content, milk has been highlighted as being particularly effective for the recovery phase following resistance exercise[13]. However, with a move towards plant-based diets and a popular rise in veganism, many consumers are now seeking alternatives to animal-based protein sources. Currently in Ireland, 2% of individuals identify themselves as vegan[14]. Meanwhile, in the past decade, the UK has seen a 360% increase in veganism with similar growth trends across Europe[15]. Sports people have also been involved in this trend, with an increase in high-profile athletes adopting vegan diets[16].

Consequently, performance nutrition research is exploring alternative sources to more traditional protein stocks such as combinations of plant-based foods, supplements and even insect sources as unconventional substitutes[17]. This article will investigate how plant-protein sources compare in the context of supporting resistance training and the accrual of lean-tissue mass. It will also address some nutritional considerations that may be important when adapting the sources of protein intake for athletes.

Protein quality in muscle recovery and the stimulation of muscle synthesis

Protein foods are not created equal. They vary according to their source (plant or animal), their quality and their digestibility. The source and, consequently, the quality of a protein can influence the magnitude of its biological effect. Proteins of high quality are those that are readily digestible when classified by their digestible indispensable amino acid score (DIAAS)[18, 19]. Common plant-based protein sources such as soy, rice, pea and hemp have consistently lower DIAAS scores compared to animal sources[16]. The greater biological value of animal-based proteins is mainly due to the presence of all essential amino acids (EAAs), whereas plant-based proteins often lack specific EAAs[16].

In the context of muscle protein synthesis, many researchers have conducted studies on amino acids to determine which may have the more potent effects and have concluded that it is the EAAs that are primarily responsible for the stimulation of muscle-protein anabolism[20-22], whereas the non-essential amino acids appear less effective in this regard[23, 24].

Among EAAs, the branched-chain amino acids, and in particular leucine, are the most efficient for stimulating muscle protein synthesis[25-27]. Leucine supplementation has also been shown to improve muscle-protein synthesis (MPS) independently of an overall increase of other amino acids[28]. The ability of leucine to influence MPS can, in part, be explained by the fact that it has a dual role in lean-tissue mass anabolism, both as a substrate and a regulator through activation of the mammalian target of rapamycin (mTOR)[29, 30]. mTOR is a protein kinase that regulates cell growth, cell proliferation, cell motility, cell survival, protein synthesis, and transcription[27].

Alternative protein sources

While no single plant source contains all EAAs or leucine in the same quantity as is found in animal sources, and in particular whey protein, it has been hypothesised that different plant sources could be combined to provide the full complement of EAAs to optimally stimulate MPS[31]. Plant protein sources, when considered in isolation, are generally deficient in one or more amino acids, usually methionine or lysine, and also contain lower quantities of leucine[31]. In order for an alternative protein to be considered a viable substitute for animal-based proteins in support of muscle-mass accrual with resistance training, it should have a high relative EAA and leucine content. Therefore, when combining plant proteins in a meal or as a post-exercise supplement, the objective is to combine sources that complement each other. The limiting amino acids from one plant protein should be provided by another, whereby the overall meal provides an adequate total EAA dose. For example, foods such as wheat, rice, hemp or maize (lower in lysine) can be combined with foods such as black bean, oat, soy, lentil or pea (lower in methionine) to achieve an adequate balance[31]. Table 1 shows the concentration of EAAs, including leucine (as % of total protein) for common protein sources.

Table 1: Amino acid concentrations of various dietary protein sources (adapted from van Vliet *et al.*[31]).

	Essential amino acids: % of total protein	Leucine: % of total protein
Animal protein source		
Whey	52	13.6
Milk	49	10.9
Beef	44	8.8
Egg	44	8.5
White fish	40	8.1
Plant protein source		
Lentil	40	7.9
Soy	38	8.0
Pea	37	7.8
Rice	37	8.2
Hemp	34	6.9

Supplemental protein powders or snacks may be a convenient option for some individuals, particularly vegan athletes who find it challenging to meet their protein requirements through food alone. Commercial blends are now available, containing combinations such as pea protein isolate with rice and hemp proteins, specifically designed to supply optimal doses of EAAs. Unconventional plant-based proteins such as spirulina are also gaining interest[32].

A more controversial consideration is insects as potential sources of dietary protein. Although they do not fall into the category of 'plant-based', insects have been proposed as a potential food security solution in feeding the growing global population[33]. The consumption of insects, termed entomophagy, is traditionally practiced in many parts of the world. Protein represents the main nutrient constituent of insects such as cockroaches, grasshoppers, crickets and locusts, which have the highest protein content at about 60-80%. The quality of insect proteins in comparison to plant or animal sources is yet to be assessed in feeding trials; however, the amino acid profile of some species looks promising[33].

Considerations for the 'plant-only' athlete

While delivering the same dose of specific amino acids from either plant or animal sources should, theoretically, be as effective at stimulating MPS, there is a lack of evidence to support the efficacy of plant proteins in optimal recovery following resistance exercise and more research is needed. The molecular mechanisms may not be the same due to the influence of the food matrix and factors such as antinutritional compounds that interfere with digestion and absorption[34]. For example, naturally occurring factors such as trypsin inhibitors, tannins and phytates have been shown to substantially reduce the amino acid digestibility of soyabeans, legumes and cereals respectively[34].

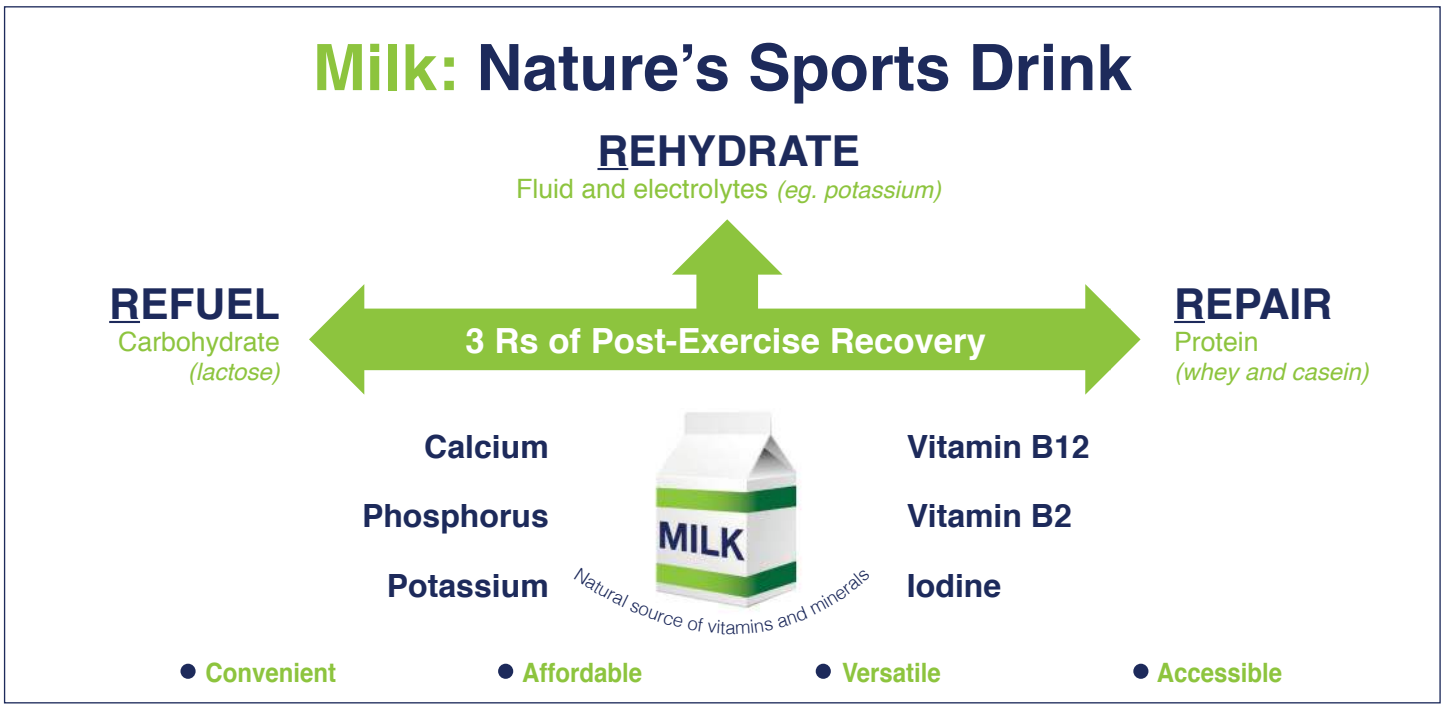
In addition, when compared to milk, proteins from soya and wheat are more readily converted to urea, which results in fewer amino acids being available to stimulate MPS[31]. Research comparing the potential effect of milk and a soya beverage on muscle accretion following resistance exercise, indicates that milk has a more favourable impact[35, 36].

A recent publication by Rogerson[16] offers some practical advice for meeting the nutritional needs of vegan athletes. It suggested that it may be prudent for vegan athletes to consume larger volumes of protein, at the upper end of the recommendations, to compensate for the poorer digestibility of plant-based sources. In relation to plant-based protein supplements, factors such as solubility and taste may impact palatability for some athletes. Also, supplementation of protein alone will not negate the losses of other important nutrients, such as vitamin B12 from milk or other animal foods, so additional supplementation with micronutrients may be necessary[16].

References:

1. Slater G and Phillips SM. Nutrition guidelines for strength sports: sprinting, weightlifting, throwing events, and bodybuilding. *J Sport Sci* 2011; 29: S67-77.
2. Cermak NM *et al.* Protein supplementation augments the adaptive response of skeletal muscle to resistance-type exercise training: a meta-analysis. *Am J Clin Nutr* 2012; 96: 1454-1464.
3. Tieland M *et al.* Protein supplementation increases muscle mass gain during prolonged resistance-type exercise training in frail elderly people: A randomized, double-blind, placebo-controlled trial. *J Amer Med Dir Assoc* 2012; 13: 713-719.
4. Cermak NM, de Groot LC and van Loon LJC. Perspective: Protein supplementation during prolonged resistance type exercise training augments skeletal muscle mass and strength gains. *J Amer Med Dir Assoc* 2013; 14: 71-72.
5. Camera DM *et al.* Protein ingestion increases myofibrillar protein synthesis after concurrent exercise. *Med Sci Sport Exer* 2015; 47: 82-91.
6. Damas F *et al.* A Review of resistance training-induced changes in skeletal muscle protein synthesis and their contribution to hypertrophy. *Sports Med* 2015; 45: 801-807.
7. McGlory C, Devries MC and Phillips SM. Skeletal muscle and resistance exercise training; the role of protein synthesis in recovery and remodelling. *J App Physiol* 2017; 122(3), 541-548.
8. Pritchett KL, Pritchett RC and Bishop P. Nutritional strategies for post-exercise recovery: a review. *S Afr J Sports Med* 2011; 23: 20-25.
9. Poortmans JR *et al.* Protein turnover, amino acid requirements and recommendations for athletes and active populations. *Braz J Med Biol Res* 2012; 45: 875-890.
10. Garlick PJ. The role of leucine in the regulation of protein metabolism. *J Nutr* 2005; 135 Suppl: 1553S-1556S.
11. Van Loon LJC. Leucine as a pharmaconutrient in health and disease. *Curr Opin Clin Nutr Metab Care* 2012; 15: 71-77.
12. Irish Universities Nutrition alliance (IUNA). (2011) National Adult Nutrition Survey [Online]. Available at: http://iuna.net/wp-content/uploads/2010/12/National-Adult-Nutrition-Survey-Summary-Report-March-2011.pdf (Accessed: February 2, 2018).
13. Sousa M, Teixeira VH and Soares J. Dietary strategies to recover from exercise-induced muscle damage. *Int J Food Sci Nutr* 2014; 65: 151-163.
14. Ryan, L and Butler-Rees E. Dairy sentiment 'benchmark study'. Behaviours & Attitudes 2017; J.8106 unpublished.
15. HRA Food and Drink Consultants. Veganism. Insights and developments in the European market 2017 [Online]. Available at: http://www.food-and-drink.marketing/veganism-insights-development/ (Accessed: January 29, 2018).
16. Rogerson D. Vegan diets: practical advice for athletes and exercisers. *J Int Soc Sport Nutr* 2017; 14: 36-51.
17. Linnemann AR and Dijkstra DS. Toward sustainable production of protein-rich foods: appraisal of eight crops for Western Europe. Part I. Analysis of the primary links of the production chain. *Crit Rev Food Sci Nutr* 2002; 42: 377-401.
18. Leser S. The 2013 FAO report on dietary protein quality evaluation in

human nutrition: recommendations and implications. *Nutr Bull* 2013; 38: 421–428.
19. Mathai JK, Liu Y and Stein HH. Values for digestible indispensable amino acid scores (DIAAS) for some dairy and plant proteins may better describe protein quality than values calculated using the concept for protein digestibility-corrected amino acid scores (PDCAAS). *Br J Nutr* 2017; 117: 490-499.
20. Volpi E *et al.* Essential amino acids are primarily responsible for the amino acid stimulation of muscle protein anabolism in healthy elderly adults. *Am J Clin Nutr* 2003; 78: 250-258.
21. Tipton KD and Wolfe RR. Protein and amino acids for athletes. *J Sport Sci* 2004; 22: 65-79.
22. Biolo G *et al.* An abundant supply of amino acids enhances the metabolic effect of exercise on muscle protein. *Amer J Physiol* 1997; 273: E122-E129.
23. Smith K *et al.* Effects of flooding amino acids on incorporation of labeled amino acids into human muscle protein. *Amer J Physiol* 1998; 275: E73-E78.
24. Tipton KD *et al.* Nonessential amino acids are not necessary to stimulate net muscle protein synthesis in healthy volunteers. *J Nutr Biochem* 1999; 10: 89-95.
25. Kirby TJ *et al.* Effect of leucine supplementation on indices of muscle damage following drop jumps and resistance exercise. *Amino Acids* 2012; 42: 1987-1996.
26. Churchward-Venne TA *et al.* Leucine supplementation of a low-protein mixed macronutrient beverage enhances myofibrillar protein synthesis in young men: A double-blind, randomized trial 1-3. *Amer J Clin Nutr* 2014; 99: 276-286.
27. Proud CG. mTOR-mediated regulation of translation factors by amino acids. *Biochem Bio Res Comm* 2004; 313: 429-436.
28. Rieu I *et al.* Leucine supplementation improves muscle protein synthesis in elderly men independently of hyperaminoacidaemia. *J Physiol* 2006; 575: 305-315.
29. Crozier S *et al.* Oral leucine administration stimulates protein synthesis in rat skeletal muscle. *J Nutr* 2005; 135: 376-382.
30. Anthony JC *at al.* Contribution of insulin to the translational control of protein synthesis in skeletal muscle by leucine. *Amer J Physiol-Endocrin Metab* 2002; 282: E1092-E1101.
31. van Vliet S *at al.* The skeletal muscle anabolic response to plant-versus animal-based protein consumption. *J Nutr* 2015; 145: 1981-1991.
32. Wu Q *et al.* The antioxidant, immunomodulatory, and anti-inflammatory activities of spirulina: an overview. *Arch Toxicol* 2016; 90: 1817-1840.
33. Bessa LW *et al.* Insects as human food; From farm to fork. *J Sci Food Agric* 2017; 1: 1-16.
34. Sarwar Gilani G, Wu Xiao C and Cockell KA. Impact of antinutritional factors in food proteins on the digestibility of protein and the bioavailability of amino acids and on protein quality. *Br J Nutr* 2012; 108 Suppl 2: S315-332.
35. Hartman JW *et al.* Consumption of fat-free fluid milk after resistance exercise promotes greater lean mass accretion than does consumption of soy or carbohydrate in young, novice, male weightlifters. *Am J Clin Nutr* 2007; 86: 373-381.
36. Wilkinson SB *at al.* Consumption of fluid skim milk promotes greater muscle protein accretion after resistance exercise than does consumption of an isonitrogenous and isoenergetic soy-protein beverage. *Am J Clin Nutr* 2007; 85: 1031-1040.



Contact us....

THE NATIONAL DAIRY COUNCIL (NDC)

The National Dairy Council
The Studio, Maple Avenue,
Stillorgan, Co. Dublin, Ireland
Tel: +353 (0)1 290 2451
Email: info@ndc.ie
Web: www.ndc.ie

NDCIreland @NDC_ie

Mission: To deliver real and unique value to Irish dairy farmers by protecting and promoting the image, quality, taste and nutritional credentials of Irish dairy produce to a wide variety of audiences in a clearly defined, focused and effective manner.

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Food for Health Ireland
Science Centre South
University College Dublin
Tel: + 353 (0)1 716 2391
Email: fhi@ucd.ie
Web: www.fhi.ie

@fhi_phase2 Food for Health Ireland

Mission: To leverage the world-class capabilities of the Irish academic partners, with the market expertise of the industry partners, into a pipeline of innovative, nutritional functional ingredients/products for the global food industry.