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THIS ISSUE

Dairy and Performance Nutrition

Pictured at the NDC & Leinster GAA Sports Nutrition Seminar for coaches: chairman of the Féile Committee, Peter O'Neill; Wexford footballer, Ben Brosnan; sports dietitian, Noreen Roche; National Dairy Council nutritionist, Caroline O'Donovan; and Wexford goalkeeper, Mary Rose Kelly. Photo: Dylan Vaughan.

Performance nutrition has emerged as a topical and exciting area of nutrition in recent decades and is now established as an integral aspect of any athlete's training and competition programme. Indeed its significance is expanding, with many principles for the competitive athlete being adapted and applied to the recreational exerciser.

Given the importance of effective recovery strategies following intense exercise on performance during subsequent exercise sessions, aspects such as the timing and composition of foods for optimal recovery have become pertinent areas of performance nutrition. Although a relatively novel strand of dairy research, the role of dairy in this context is gathering pace, with promising applications including post-exercise roles in rehydration and muscle recovery.

The effectiveness of skimmed milk as a post-exercise rehydration drink has been mainly attributed to its fluid and naturally occurring electrolyte content, with studies demonstrating that milk maintains hydration status equally, or better than, a commercially available sports drink. Moreover, from a practical perspective to the athlete, milk is considered a convenient, accessible and inexpensive beverage.

There has been a strong interest in dairy protein due to its composition of branched chain amino acids (BCAAs), particularly leucine, and their role in promoting muscle recovery and, ultimately, muscle adaptation. Studies have shown that drinking milk post-exercise can help to alleviate muscle damage and soreness, and subsequent decrements in muscle performance. Furthermore, flavoured milk, particularly chocolate milk, has been noted in the literature as an effective post-exercise recovery drink. Additionally, most commercially-available powdered protein supplements are derived from dairy/milk proteins.

Previously in *DN Forum*, Food for Health Ireland (FHI) outlined research into nutrition and lifestyle strategies aimed at addressing age-related deterioration of muscle mass and strength. Acknowledging that the nutrients required for healthy muscle in ageing are fundamentally similar to those needed to improve sports performance, phase 2 of FHI's research will additionally focus on performance nutrition. With this, FHI aims to develop a range of products to support recovery, growth and repair of muscle following strenuous endurance and high-intensity exercise.

"The area of performance nutrition is of huge interest to FHI, and our research in this area is closely associated with our healthy ageing work-stream," says Jens Bleiel, CEO, FHI. "The sports nutrition market represents significant opportunities for the dairy industry and FHI is working to ensure that the roles and applications of dairy and dairy constituents are fully explored and recognised for their importance in performance nutrition."

EDITORIAL

Performance nutrition is the focus of this issue of *DN Forum*. The impact and importance of diet and nutrition on sports performance is becoming increasingly recognised; and is now a major consideration for sports people. In addition, performance nutrition is becoming more relevant to a mainstream market with recreational athletes and active individuals also showing interest in the application of performance nutrition concepts.

In parallel, performance nutrition research continues to evolve and develop. The potential role for dairy in recovery after exercise has been the focus of many recent studies, with positive and promising results emerging.

The Expert Review by Dr Brendan Egan (page 2&3), summaries the evolvement of, and current focuses within, sports nutrition research, including the role for dairy and the application of dairy constituents.

The National Dairy Council (NDC) is actively contributing to this area, commissioning research and hosting seminars with sporting bodies to educate and inform professionals on the importance of sports nutrition and how dairy and dairy-based products can contribute to the diet of athletes.

As always, please feel free to share your comments and feedback: nutrition@ndc.ie

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Expert Review

Recovery from exercise and sports performance – is there a role for dairy?

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Dr Brendan Egan

The challenge of intense exercise: implications for recovery

Because of the physiological stress of exercise, during recovery from exercise and sports performance, many major restorative processes are activated including: recovery of fuel stores; repair of damaged muscle; restoration of fluid and electrolyte balance; lactate oxidation and removal; and inflammatory and anti-inflammatory responses.

Two main processes are the subject of much research and directly influenced by nutrient intakes during recovery[1]. The first process is the replenishment of muscle fuel stores, also known as glycogen resynthesis[2]. Given the long-established relationship between pre-exercise glycogen concentration and exercise capacity[3], a major focus for sports nutritionists has traditionally been to implement nutrition strategies that maximise muscle glycogen resynthesis in order to recover for subsequent training or upcoming competitive performance.

The second process is the repair, growth and remodelling of muscle, for which a surrogate measure, known as muscle protein synthesis (MPS) is used[4]. Intense exercise damages muscle (necessitating repair), stimulates adaptation, and increases protein turnover. Intake of essential amino acids (EAAs), especially the branched chain amino acids (BCAAs), and most importantly, leucine, are necessary to promote recovery[5] and to elevate MPS[4].

Optimising recovery is paramount to sports nutrition strategies as these processes directly influence the ability to perform subsequent exercise, and the nature of adaptation to exercise especially in relation to the growth of muscle mass[1].

Development of the recovery nutrition paradigm

Almost half a century ago, the remarkable ability of muscle to rapidly restore carbohydrate stores during recovery was noted[6]. Early sports nutrition research examined carbohydrate feeding specifically on the restoration of muscle glycogen stores, but this approach gave no consideration to other aspects of the recovery process such as MPS, muscle damage and repair - factors that comprise a holistic approach to recovery.

Arising from seminal work from the Ivy[7,8] and Wolfe[9,10] laboratories, exploring protein and amino acids (AAs) fed with carbohydrate, and complimented by recent work from the Phillips[4] and van Loon[11] laboratories, several key nutrition strategies for recovery have been established, primarily focussing on the influential effects of: (a) the timing of feedings; and (b) the composition of nutrients. Much of this work now focuses on the optimal blend of carbohydrate and protein, and in particular the role for dairy-derived proteins in this paradigm[4, 11, 12].

Nutrient timing and the post-exercise window of opportunity

The 'nutrient timing' concept has emerged as one of the most important concepts in sports nutrition in the last decade. Simply put, instead of focussing only on *which* nutrients are eaten, *when* those nutrients are eaten - around training sessions and competition - can have a dramatic effect on the metabolic response to that session, recovery from that session and influence changes in body composition[12].

One factor that explains why nutrient timing is important is a phenomenon known as the 'post-exercise window of opportunity' (Figure 1). This is a short period of time (up to four hours) after exercise where anabolic recovery processes in the body are maximised. For instance, the rate at which muscle can recover its fuel stores by converting carbohydrate-containing foods into

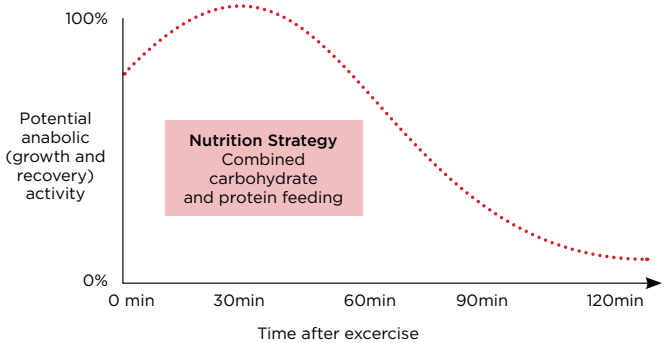


Figure 1. The post-exercise window of opportunity – setting the stage for nutritional recovery.
For a short period of time (up to four hours) after exercise, anabolic recovery processes in the body are maximised including glycogen resynthesis and MPS. During this time, the body offers the greatest potential to rapidly start the storage of muscle carbohydrate and recovery and repair of muscle protein. The practical implication is that by providing the body with nutrients as soon as possible after exercise, activation of a variety of recovery processes are optimised.

muscle glycogen, or can increase MPS, is markedly reduced if the consumption of a recovery meal is delayed by two to three hours[10, 13-15].

Nutrient composition during recovery

The composition of optimal nutrition strategy for recovery is one that combines both a source of carbohydrate, and a source of protein, while limiting fat intake[1]. The efficacy occurs because carbohydrate provides a source of glucose for the resynthesis of glycogen, whereas protein provides AAs for stimulation of MPS. Moreover, a synergistic effect arises from glucose and AAs together stimulating insulin secretion, which in turn, acts as an anabolic hormone to stimulate these recovery processes[11, 16]. Several studies support the recovery benefits of combined carbohydrate-protein intakes over carbohydrate alone[7-10, 17, 18].

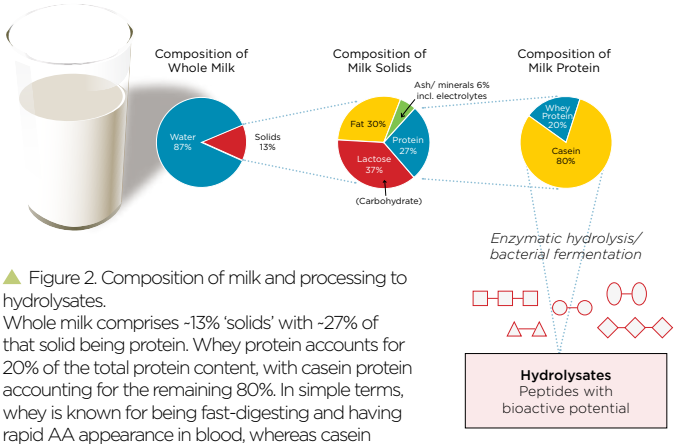
Consensus from the International Society of Sports Nutrition[12] suggests ratios of carbohydrate-to-protein of 3:1 and 4:1 or 5:1 are optimal for glycogen resynthesis and MPS, respectively. Specifically, a combination of sources of high glycemic index carbohydrate and fast-digesting protein or EAAs is suggested to be the 'perfect' recovery blend[16].

A potential role for dairy in recovery?

Recent work has focused on milk as a recovery aid. Since milk contains both carbohydrate and protein (Figure 2), it has been proposed as a low-cost alternative to commercial powdered recovery supplements. Milk contains both whey and casein proteins, which contribute to AA availability and stimulation of MPS[19]. Milk also provides fluid and electrolytes, which are essential for adequate rehydration, another important recovery process[20].

On the whole, the evidence for milk as a post-exercise recovery aid is promising with beneficial effects reported for hydration[21] and indices of muscle damage[22].

With regard to the source of protein during recovery, a clear efficacy exists for EAAs, especially BCAAs and leucine, in recovery[5,23]. Dairy protein is one of the richest food sources of BCAAs, with up to one-third of the total AA content accounted for by BCAAs. Dairy proteins stimulate MPS to a greater extent than plant-based proteins[24], and whey protein stimulates MPS to a greater extent than casein protein[25], so the choice of protein often depends on the application.



▲ Figure 2. Composition of milk and processing to hydrolysates.

Whole milk comprises ~13% 'solids' with ~27% of that solid being protein. Whey protein accounts for 20% of the total protein content, with casein protein accounting for the remaining 80%. In simple terms, whey is known for being fast-digesting and having rapid AA appearance in blood, whereas casein is known for being slower-digesting and having delayed AA appearance in blood. Hydrolysates are produced by enzymatic pre-digestion or bacterial fermentations of protein, resulting in shorter polypeptide chains that are more rapidly digested and absorbed, often as dipeptides and tripeptides with bioactive potential. When combined with carbohydrate in a recovery drink, these hydrolysates have potent effects on both glycogen resynthesis and MPS through rapid delivery of AAs into the bloodstream, and by eliciting an exaggerated insulin response.

Powdered recovery formulations including protein are some of the most popular dietary supplements used by adult athletes[26,27]. Because of the rich BCAA content, ease of flavouring and mixability, many commercial powdered protein supplements are derived from dairy proteins. However, there are simple food combinations that combine dairy protein with carbohydrate sources, which are useful for recovery (Figure 3).

MELON & MINT SMOOTHIE
1 scoop whey protein powder
1 honeydew melon
Handful fresh mint leaves
1 lime
1cm cube of fresh ginger
300ml water

YOGHURT, DRIED FRUIT & PUMPKIN SEEDS
250g natural yoghurt
100g dried fruit
2 tbsp pumpkin seeds

MILK & BANANAS
½ litre milk
2 bananas

COTTAGE CHEESE MESS
150g cottage cheese
100g raspberries
50g pine nuts
20g pumpkin seeds
4 red grapes
2 tsp dessicated coconut
1 tsp honey
2 tbsp chopped almonds

▲ Figure 3. Dairy-based recovery snacks.

Each snack provides a blend of protein rich in essential and branched chain amino acids, and healthy, nutrient-rich sources of carbohydrate, which would form part of a recovery strategy targeting carbohydrate-protein ratios of 3:1 up to 5:1, and providing 2*25 g doses of protein in the first four hours after exercise. The challenge of exercise training as much as doubles the dietary protein requirement for active adults and athletes (ranging from 1.2 to 1.8g per kg body mass per day) compared to the RDA for the general population.

Value-added ingredients: Dairy protein hydrolysates

Dairy protein hydrolysates (Figure 2) have gained popularity due to the concept of nutrient timing and desire for rapid changes in AA concentrations desired by athletes. Beyond recovery and sports performance, these novel peptides can exhibit bioactive properties including anti-hypertensive, immunomodulatory and insulinotropic properties that have applications for healthy ageing[28]. Work is currently underway within Food for Health Ireland (FHI) to mine hydrolysates from dairy protein and investigate their bioactivity on various biological parameters, wherein work in my laboratory explores these effects on blood glucose control and recovery from intense exercise.

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EVIDENCE TO PRACTICE

Significance of this research to:

A. INDUSTRY

Whether elite athletes or weekend warriors, the message of recovery, and its importance, is universal and an important market segment. Dairy protein has a valuable role in recovery and in particular, the production of hydrolysates and/or bioactive peptides from dairy protein, with favourable effects either on glycogen synthesis or MPS (or both), would result in the production of high value-added ingredients suitable for inclusion in a range of sports nutrition formulations.

B. HEALTH PROFESSIONALS

Optimising the composition and timing of recovery nutrition would help athletes to recover quicker between training sessions, prepare better for competitive performance, and enhance muscle growth or maintenance depending on their goals. Dairy protein, being rich in leucine and BCAAs, is an attractive component for inclusion in a recovery strategy.

C. THE PUBLIC

Replenishment of muscle fuel stores and repair of damaged muscle should be a priority after intense exercise, and this is best accomplished by a combination of carbohydrate and protein soon after exercise. Dairy-based snacks have potential to augment these processes and are a convenient way to obtain the required amount of protein, and have the added benefit of being rich in important amino acids.

Key Points

- Two main recovery processes that are the subject of much research and directly influenced by nutrient intakes during recovery are: the recovery of muscle fuel stores in the form of carbohydrate (glycogen resynthesis); and the repair, growth and remodelling of muscle tissue (muscle protein synthesis).
- Optimising both of these recovery processes is paramount to sports nutrition as these processes directly influence: the ability to perform subsequent exercise training/ competition; and the nature of adaptation to exercise especially in relation to the growth of muscle mass.
- Studies on nutrient timing and composition during recovery suggest that optimal recovery and adaptation to training are achieved by maximising the anabolic (growth and recovery) environment, in the post-exercise period, beginning immediately after the end of exercise or performance.
- This can be best achieved by nutrition intakes during recovery that incorporate sources of carbohydrate and protein at a ratio from 3:1 up to 5:1 for at least the first four hours of recovery.
- The protein source should be rich in essential amino acids, which makes dairy protein an attractive component to incorporate into any post-exercise recovery strategy. Promising results for milk as a recovery product in terms of rehydration and muscle repair have been published.
- The potential exists to process dairy protein using enzyme hydrolysis that can result in the formation of bioactive proteins that would provide value-added ingredients, in terms of sports nutrition and healthy ageing applications.

NDC Sports Nutrition Engagement

- The NDC recently financed a research project evaluating skimmed milk as an effective rehydration drink following exercise-induced loss of body water. Results from this project, conducted by the University of Limerick, will be available soon.
- The NDC is working with sporting bodies to help ensure coaches and trainers are educated, and kept up-to-date, on sports nutrition through a series of educational seminars. Below is the 2015 schedule.

Sports association	Date	Location	Sports nutritionist	Sports star
The Camogie Association of Ireland	Feb 2015	Laois	Nóra Ní Fhlannagáin	Senior All-Ireland camogie champion and All-Star, Kate Kelly
Leinster GAA	March 2015	Wexford	Noreen Roche	Wexford footballer, Ben Brosnan Wexford goalkeeper, Mary Rose Kelly
Coaching Ireland	May 2015	Limerick	Noreen Roche	TBC
Cycling Ireland	Sept 2015	Dublin	TBC	TBC

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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, unique and effective manner.

FOOD FOR HEALTH IRELAND (FHI)

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@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.