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National Dairy Council

MILK & EXERCISE RECOVERY

THE SCIENCE

POWER FROM THE GROUND UP

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Contents

Editorial

The impact and importance of nutrition for sports performance is well recognised; and is now a major consideration for those participating in sport and exercise.

Research highlighting milk's role as an effective recovery option post-exercise has gathered pace over the past decade or so. The National Dairy Council continues its focus in this area, working with sport and exercise organisations; publishing useful resources for coaches, trainers and athletes; and supporting relevant research.

This publication for sports, fitness and health professionals summarises the evolution of the scientific research exploring the role of milk in post-exercise recovery nutrition. Also included are insights by leading experts and researchers working in this exciting area of recovery and performance nutrition.

We hope you enjoy this resource and look forward to any feedback or comments you wish to share: nutrition@ndc.ie

Caroline Gunn

Caroline Gunn
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Summary Points

- Effective recovery following intense exercise is integral for any athlete to ensure subsequent performance is not compromised. The scientific evidence supporting the role of milk as an effective recovery option has gathered pace in recent years, with applications including roles in rehydration and muscle recovery.
- Milk has been shown to hydrate better than water and equally as good as a commercially-available sports drink; with 500 ml of low-fat milk post-exercise shown to attenuate exercise-induced muscle damage.
- Milk's effectiveness is attributed to its natural nutritional composition which assists in the key components of post-exercise recovery. Milk contains a natural source of carbohydrate (lactose) to support glycogen resynthesis; complete protein and branched chain amino acids (BCAAs) for muscle protein synthesis (MPS); as well as being a source of fluid and electrolytes to support rehydration.
- Chocolate milk has also been highlighted in the literature as a popular recovery solution, with similar or superior benefits demonstrated when compared to other recovery drinks.
- From a practical perspective for the athlete, milk is considered a natural, convenient, accessible and inexpensive recovery option.
- Although the research is expanding in this exciting space, there is still much to be investigated in order to determine the extent of milk's role in performance and recovery nutrition across a range of different sports and at various competitive levels.

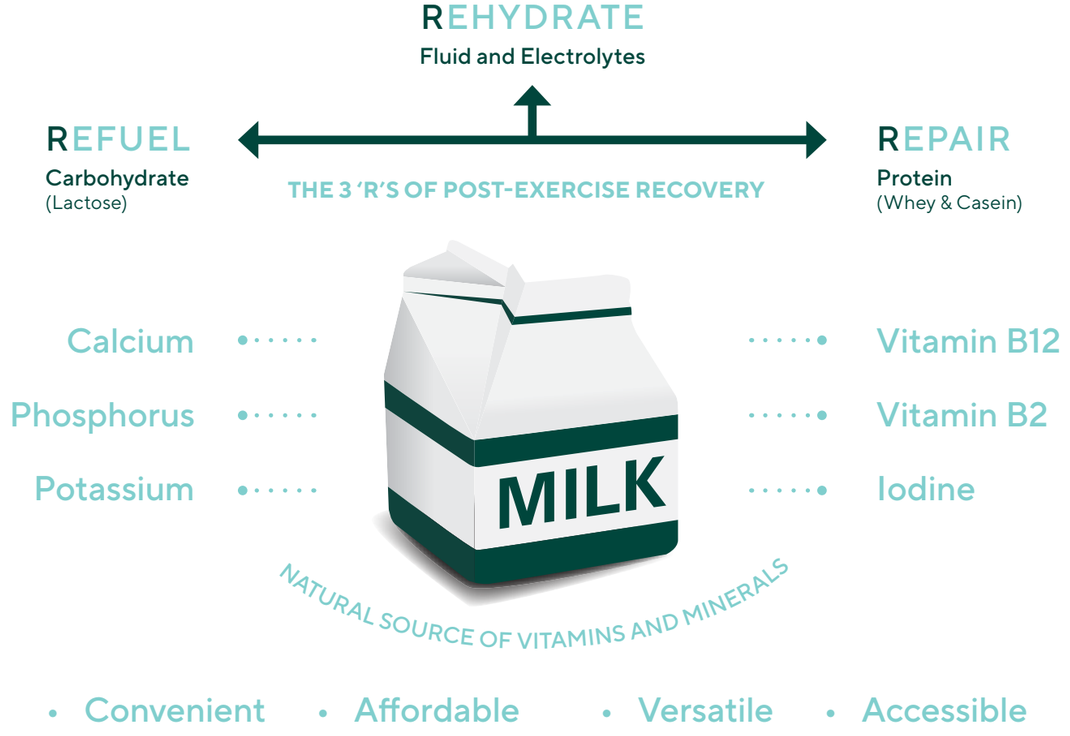

Figure 1. The attributes of milk that contribute to post-exercise recovery and health.

Introduction

Sport and exercise elicit a number of biochemical, mechanical and physiological responses in the body. Therefore, it is necessary for sports and fitness enthusiasts to optimise their recovery in order to perform their best at the next competition, training session or match[1-3].

Although a relatively novel strand of dairy research, milk has been highlighted in the literature as an effective recovery option post-exercise[4,5]. Milk's effectiveness is attributed to its natural and unique nutritional composition which satisfies the key components of acute recovery nutrition[6], as well as benefits for chronic adaptation to training[7]. Milk provides the naturally occurring sugar lactose to support glycogen resynthesis; is a fluid and electrolyte source to assist with rehydration; and provides whey protein and branched chain amino acids (BCAAs) which are associated with the stimulation of muscle protein synthesis (MPS)[6-8].

Milk's attributes as a convenient, affordable, widely available and versatile beverage have also contributed to its popularity as a post-exercise recovery option[7,9].

Additional research has expanded to explore the role of skimmed milk in reducing energy intakes at a subsequent meal, suggesting a possible advantage to those exercising for the purpose of weight management[7,8,10]; as well as favourable effects on blood glucose and fat oxidation when consumed as a post-exercise drink[11].

Indeed, the research is expanding in this exciting space, with much more to be investigated and explored[12].

This publication will provide an overview of the evolution of the scientific research to date which has demonstrated the beneficial role for cow's milk in post-exercise recovery nutrition.

Expert Insight

Why Performance Nutrition Matters

"Paying attention to eating and drinking habits can impact greatly on the performance of all athletes at all levels. Food is an effective performance enhancer in many ways. It provides us with energy, it builds and rebuilds the body and it can deliver nutrients that are the building blocks of many of the physiological processes involved in exercise."

Dr Sharon Madigan
RD, PHD, RSEN
Head of Performance Nutrition, Sport Ireland Institute

"Training plans rarely stay static so neither should nutrition routines. All athletes will benefit if they tailor their food intakes to suit their own individual needs and are aware that these needs can change throughout the training and competition seasons.

Remember one size does not fit all. Athletes from different sports will have different requirements for different nutrients. For example, endurance athletes will have greater energy and carbohydrate needs than athletes from other sports.

If deciding to use nutritional supplements, a clear plan of how they could impact performance is needed and it is best to seek advice from a sports dietitian. There may not be a need for any – as foods, if used appropriately, can generally meet all nutritional needs."

Recovery Nutrition

Key Considerations

The application of effective nutritional recovery strategies is a well-established priority following intense exercise in order to attenuate decrements in subsequent performance. Aspects such as the timing and composition of foods are pertinent areas of consideration for optimal recovery[13,14].

Endurance exercise elicits depletion of energy stores and muscle protein catabolism[1]. Therefore, refuelling of muscle glycogen stores; optimal muscle repair; and restoration of fluid balance are main considerations for post-exercise recovery[1,15,16].

Refuelling Glycogen Stores

During intense exercise muscle glycogen is used as the main fuel source, with depletion of muscle glycogen associated with fatigue[1]. However, as the body has a limited capacity to store glycogen, carbohydrate intake is needed to replenish these stores for subsequent activity[17].

Carbohydrate requirements before, during and post-exercise will depend on a number of aspects such as the duration and intensity of the session; performance and body composition goals; as well as the duration of time available to recover between sessions[18,19]. For effective recovery, consuming carbohydrate following high-intensity/endurance-type exercise is necessary for effective replenishment of muscle glycogen stores[20,21]; as well as to stimulate insulin production which, in turn, stimulates amino acid uptake by muscles[22]. To fulfill both the provision of amino acids and glucose for these purposes, co-ingestion of protein and carbohydrate is suggested within 30-60 minutes post-exercise[20].

For extrapolation to quantities per bodyweight, approximately 0.8 g/kg/hr of carbohydrate with 0.2-0.4 g/kg/hr of protein is advised immediately after and each hour for 4-6 hours following intense exercise[23]. To simplify, this is generally interpreted as 50 g of carbohydrate with 15-25 g of high quality protein[18,20,24,25].

Optimising Muscle Repair

Muscle protein breakdown and muscle protein synthesis are both stimulated in response to exercise[26]. In relation to team sports, such require intermittent bursts of high-intensity movement interspersed with lower-intensity activity[27], which can result in substantial muscle damage[25, 27].

Associated with muscle damage is power and strength loss and impairments of neuromuscular and reflex actions – which can adversely affect performance[28]. For the recreational exerciser, attenuating muscle soreness post-exercise is also favourable in order to encourage adherence to exercise regimes, which can, in turn, have beneficial effects on weight management or fitness goals[7].

Provision of amino acids post-exercise is necessary to stimulate insulin-signalling and the critical mTOR pathway, which is needed to achieve net protein synthesis[29,30,31]. Specifically, the consumption of 15-25 g of high biological value protein such as eggs, meat and particularly milk/whey is advised for optimal muscle protein synthesis[18,20,24,25]; with leucine (>2.2 g[32]) recognised as a potent signalling amino acid of the mTOR pathway[33]. In addition to sufficient amino acid intake to achieve net protein accretion[30], co-ingestion with carbohydrate assists by stimulating insulin release for efficient uptake of amino acids into the muscle[22].

Restoring Fluid Balance

Dehydration can negatively impact on a myriad of performance aspects such as decision-making, concentration and motor control, with a fluid deficit as low as 2 % body weight associated with such negative effects[34].

A fluid deficit affects most athletes after exercise, with adequate fluid volume and supply of electrolytes needed for sufficient rehydration[1,15]. Therefore, in addition to glycogen replacement and protein synthesis, a third priority for the athlete is to restore fluid and electrolyte balance[34,35]. Following exercise, it is recommended to ingest a fluid quantity of 125-150 % of body weight lost; and to replace sodium lost through sweat[36,37,38], with a concentration of 50-80 mmol/L sodium suggested for optimal hydration in fluid or food form[39].

Milk's Natural Composition

Addressing Recovery Needs

A UNIQUE NUTRIENT PACKAGE

The effectiveness of milk as a post-exercise recovery option has been attributed to its natural nutritional composition, which assists in addressing the 3 'R's of post-exercise recovery – Refuelling of glycogen stores; Repair of muscles; and Rehydration.

Milk contains water, carbohydrate, protein and electrolytes such as sodium and potassium; as well as being a source of essential vitamins and minerals including calcium, iodine, phosphorus, riboflavin (vitamin B2) and vitamin B12 which play a number of important roles in health[40].

For example, milk provides calcium, protein and phosphorus to assist in the maintenance of normal bones; protein contributes to muscle growth and maintenance; vitamin B12 contributes to the normal function of the immune system and the reduction of tiredness and fatigue; iodine plays a role in normal cognitive function; while phosphorus, riboflavin and vitamin B12 assist with energy metabolism (Figure 2).

As well as assisting in meeting nutrient recommendations, research is demonstrating a neutral or protective role for milk and dairy products against the development of chronic diseases such as obesity, type 2 diabetes, cardiovascular disease and some cancers[41,42]. It has been suggested that some of these health effects may be attributed to the unique nutritional composition and interaction of milk's nutrients and components working together in synergy – referred to as the 'milk matrix' effect – rather than the effects of these nutrients in isolation[43,44].

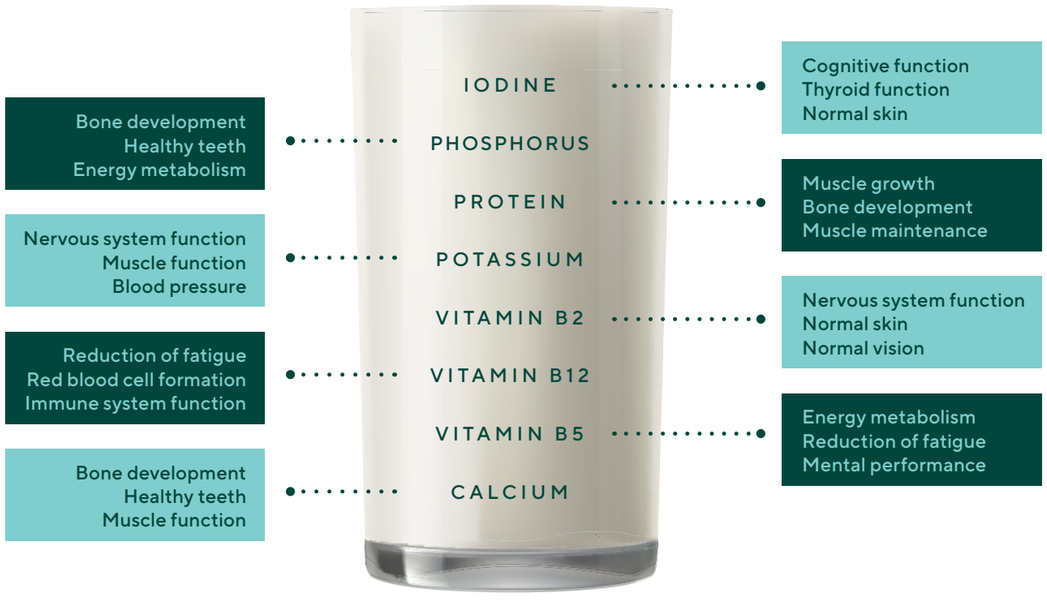

Figure 2.
Milk and dairy foods provide a rich matrix of nutrients which contribute to many normal functions in the body[40,47,48].

Did you know?
Calcium is a key nutrient for bone health, with calcium naturally lost through sweat when we take part in excessive or prolonged exercise. Research among female cyclists has demonstrated that a dairy-based meal pre-exercise negated calcium loss and reduced bone breakdown[45,46].

Refuelling

Milk's Carbohydrate - Lactose

Milk provides carbohydrate in the form of the naturally occurring, low glycemic-index (GI) sugar lactose[49] – a disaccharide comprising of glucose and galactose[50]. The concentration of milk carbohydrate at 4.8 % is within the range of most commercially available sports drinks (4-8 %) – a range acknowledged to improve endurance performance as well as ensuring minimal gastric discomfort[35,51]. High GI sugars are particularly advantageous to refuel glycogen stores when exercise sessions are in close succession[21,52]. However, while high GI foods can assist in a quick start to refuelling, low GI foods have been shown to refuel glycogen stores as effectively as high GI options after 24 hours[53,54]. Indeed, the co-ingestion of protein and carbohydrate in the quantities naturally provided by milk is suggested to elicit similar resynthesis of muscle glycogen when compared to an isocaloric carbohydrate-electrolyte drink (sports drink)[8]. Additionally, it is suggested that the monosaccharide galactose (of which lactose is comprised of alongside glucose) is more favourably synthesised by liver glycogen than glucose, indicating another beneficial mechanism for the role of lactose in the glycogen replenishment process after exercise than a glucose-only source of carbohydrate[7].

Flavoured milks such as chocolate milk have also been highlighted as a popular and effective recovery option[8,55,56], attributed to a favourable 3.5:1 carbohydrate to protein ratio[57,58] to support effective stimulation of muscle protein synthesis[59,60]. Indeed, a recent review by Amiri *et al*[9]. concluded that chocolate milk "*either provides similar or superior results on recovery indices compared to other recovery drinks and thus represents an alternative and often economic replacement*". As with plain milk, chocolate milk's effectiveness has been attributed to its nutritional composition; consisting of a similar nutritional profile to low-fat milk in terms of fat, protein, vitamin and mineral profile – but offering an additional 7 g per 100 ml of carbohydrate content due to added sugars[47,58]. This additional carbohydrate assists to optimise glycogen replenishment post-exercise, as well as assisting amino acid uptake into muscles via stimulation of insulin release[7].

LACTOSE, THE FACTS...

Milk contains the naturally occurring sugar lactose (approximately 5 g per 100 ml), as indicated on nutritional information labelling. Nutritionally, lactose is not classified in the same category as 'free' or 'added' sugars. Generally, sugar is not added to milk unless specified in the ingredients list e.g. in flavoured milks.

Both the Scientific Advisory Committee on Nutrition (SACN)[61] and the World Health Organisation (WHO)[62] have focused on restricting added or free sugars, generally defined as 'all monosaccharides and disaccharides added to foods by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups and unsweetened fruit juices'.

Repair

Milk Protein - Casein and Whey

Dairy protein comprises of casein and whey fractions (approximately 80 % and 20 % respectively)[50,63], with this 4:1 ratio allowing for slow digestion and absorption and, in turn, sustained increase of amino acid concentration in the blood[64]. Because of this, milk protein has been associated with favourably influencing muscle protein synthesis (MPS) and recovery post-exercise[65]. Whey protein has received considerable focus in relation to performance nutrition, recognised as a valuable source of branched chain amino acids [BCAAs][66]. Whey-derived BCAAs are particularly noted for their role in MPS[67,68], with greater MPS stimulation demonstrated compared to casein or soy protein[69,70]. Additionally, whey protein is particularly high in the rapidly-digested amino acid leucine; which is acknowledged for its anticatabolic properties, regulation of protein metabolism and promotion of MPS[71,72].

Casein is also a complete protein, providing all of the essential amino acids[50]. In contrast to whey, which is considered a 'fast' protein, casein is a 'slow' protein as it is emptied at a slower rate from the stomach, allowing for a more prolonged rise in levels of plasma amino acids[63,73,74]. Because of this, the timing of casein consumption in recovery nutrition has been suggested pre-sleep to supply amino acids in order to support muscle protein synthesis during the hours of sleep[75].

Milk has been highlighted among a list of natural foods that effectively address recovery from exercise-induced muscle damage [EIMD][4,5]. Specifically, 500 ml of semi-skimmed milk has been demonstrated as an effective post-exercise option to attenuate EIMD in males and females[76-82] and has shown improvements in certain aspects of team sport performance such as agility and sprinting. Milk's effective role in muscle recovery is attributed to its provision of essential amino acids, as well as insulin-stimulating carbohydrate in the form of the naturally occurring sugar lactose to promote MPS[6,8,68].

The consumption of 15-25 g of high biological value protein is advised post-exercise for effective MPS[18,20,24,25], with a 500 ml volume of milk consumed, as in much of the research, providing 17.5 g of protein[47]. Protein milks, which have approximately 50 % additional whey and casein protein added to typically provide 25 g protein per 500 ml, have emerged as a convenient option for facilitating the optimum quantity of protein intake (25g) from one source[83]. Dairy protein recovery powders are also recognised as a convenient way of meeting needs due to their high BCAA content, ease of flavouring and ability to blend[83,84]. Milk-derived bioactive peptides are also being assessed for recovery of contractile function following both resistance and endurance exercise through key mechanisms such as muscle protein synthesis and glycogen resynthesis[84].

Expert Insight

Exercise-induced Muscle Damage

"Milk is a nutrient-dense food that contains high quality protein and other important constituents. It is the natural nutritional components of milk that has led to the growing body of research exploring the potential role of milk and milk-based products in sports nutrition – from the elite athlete to the recreational exerciser. Our research has shown that ingestion of milk post-exercise can alleviate the negative effects of exercise-induced muscle damage, enabling athletes to perform better on subsequent days after a hard bout of exercise."

Professor Emma Stevenson
Professor of Sport and Exercise Science, Newcastle University.

Rehydration

Milk -Fluid & Electrolytes

Milk is typically composed of approximately 88-91% water (Table 1). and provides the electrolytes sodium, potassium, calcium, magnesium, chloride, phosphate and sulphate[50] – which are among the major electrolytes lost through sweat[85]. Additionally, the energy density and protein content of milk are proposed to delay the gastric emptying of milk and slow down its entry into circulation; helping to prevent diuresis and therefore enhancing fluid absorption[7,86-91].

The inaugural investigation into milk as an effective rehydration beverage by Shirreffs *et al.* (2007) observed that participants remained euhydrated during a 4-hour recovery period following skimmed milk consumption compared to water or a commercially available carbohydrate-electrolyte drink[86]. Similar studies have since supported these results among adult participants using a metered approach[87] and active youths[88,89]. Indeed, in a recent review by Russo *et al.*, it was suggested that post-exercise milk intake achieves a more positive fluid balance compared to an isovolumetric intake of water; and/or a commercially-available sports drink[8].

Conclusion

Milk's effectiveness as a post-exercise beverage is attributed to its natural nutritional composition which assists to satisfy the key components of post-exercise recovery (Table 1). Milk contains a natural source of carbohydrate (lactose) to support glycogen resynthesis; complete protein and branched chain amino acids (BCAAs) for muscle protein synthesis (MPS); as well as being a source of fluid and electrolytes to support rehydration. From a practical perspective to the athlete, milk is considered a natural, convenient, accessible and inexpensive recovery option.

Although the research is expanding in this exciting space, there is still much to be investigated in order to determine the extent of milk's role in performance and recovery nutrition.

Future research suggestions include: larger studies with consistent measures of recovery to determine more accurate comparisons; a focus on the recreational athlete, as well as those highly trained or participating at a competitive level; studies involving players across the life stages and an adequate representation of both sexes; investigation across a variety of different sports and exercise activities; and the variable effects of acute versus chronic supplementation with milk post-exercise. The role of other dairy products, such as yogurt and cheese, in performance and recovery nutrition is also yet to be elucidated.

Table 1

The nutritional composition (g/100g) of commercially available milk.

Nutrient	Whole Milk	Skimmed Milk	1% Fat Milk	Protein Milk	Chocolate Milk (low-fat)
Energy (Kcal)	63	34	41	49	72
Energy (KJ)	265	144	173	206	305
Water	87.6	90.8	90.1	-	82.8
Carbohydrate (g)	4.6	4.8	4.8	4.8	11.7
Sugars (g)	4.6	4.8	4.8	4.8	11.0
Lactose (g)	4.6	4.8	4.8	4.8	5.5
Sucrose (g)	0	0	0	0	2.8
Fructose (g)	0	0	0	0	1.7
Maltose (g)	0	0	0	0	1.1
Protein (g)	3.4	3.5	3.5	5.1	3.6
Fat (g)	3.6	0.3	1.0	1.0	1.5

Research Spotlight

Milk and Rehydration

Suzanne is a senior dietitian in cardiology and stroke at Galway University Hospital and currently lectures on the MSc. Preventive Cardiology programme at NUI Galway.

Suzanne completed her MSc by research[87] in exercise nutrition at the University of Limerick, exploring the role of milk in rehydration post exercise.

How did you go about conducting your research?

Males (n=7) aged 26 years with a mean body mass (BM) of 86.4 kg were recruited to this study. The dehydration protocol involved cycling on a cycle ergometer in heat (30°C), to achieve a 2 % BM loss, which is the cut off traditionally associated with impaired sports performance[35,86]. Many studies typically employ a 1 h bolus rehydration strategy involving consumption of a volume equivalent to 1.5 times the BM loss.

However, ingesting ≥ 2 L of fluid within a short time frame (≤ 1 h) may be associated with gastrointestinal disturbance[86] and cause the kidneys to increase urine output[92] which can limit the body's ability to retain the fluid[92]. Unique to this study was the utilisation of a metered approach of fluid ingestion, comparing 0.1 % fat milk, a commercially available carbohydrate-electrolyte solution and water. Changes in BM, plasma osmolality, urine osmolality and urine volume were measured to assess hydration status over time.

What were the main findings from your study?

Net fluid balance (NFB) was calculated from the change in BM (reflecting the loss of fluid by sweating) plus fluid ingested minus urine produced. At the end of the 5 h rehydration period NFB in the milk trial remained in positive balance (+117 [SD 122] ml) compared with water (−539 [SD 390] ml) but not significantly greater than the carbohydrate-electrolyte drink (−381 [SD 460] ml) (Figure 1).

"This research study demonstrates that rehydration with milk is as effective as a commercially available sports drink and more effective than water alone."

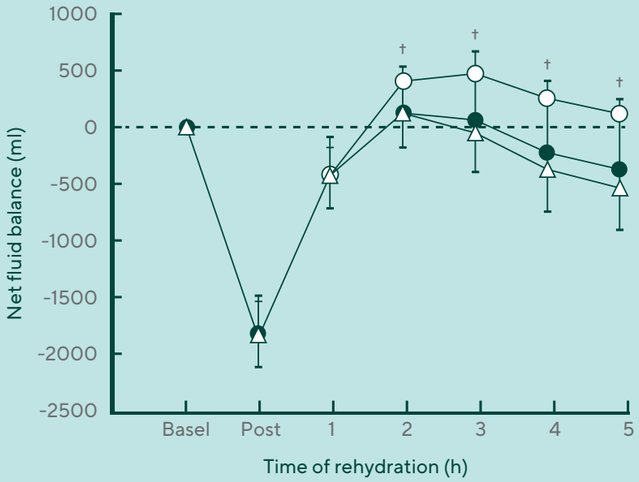

Figure 1. Fluid Balance

Net fluid balance over the course of the experimental trials. Values are means and standard deviations represented by vertical bars.

- Milk Trial
- Carbohydrate-electrolyte Trial
- Water Trial

† Value of Milk Trial is significantly different from Water Trial (P<0·05).

Research Spotlight

Milk and Muscle Recovery

Dr Paula Rankin is Head of the Department of Science and Health at the Institute of Technology, Carlow. Paula's research interests Include the impact of recovery interventions on subsequent performance; maximising recovery from exercise-induced muscle damage; functional foods and recovery; energy balance in athletes; and the physiological demands of female sport.

What is the background to your research?

The effect of milk on recovery from exercise-induced muscle damage (EIMD) has been logically investigated by Cockburn and colleagues in a landmark sequence of studies[76-79] and it is clear that 500ml milk following muscle damaging exercise can attenuate decreases in muscle functional capacity in males including peak torque, reactive strength index (RSI) and sprint performance.

We found similar benefits in females[80]. However, the nature of the exercise protocols utilised in these studies (isolated eccentric protocols) is quite unlike the exercise stress experienced by most exercising athletes, and hence, we wanted to explore the role of milk in the recovery from other, ecologically valid forms of exercise in order to provide appropriate guidelines to athletes.

How did you go about your research?

In order to investigate the effect of milk on recovery from a sport-specific exercise protocol eighteen female team sport athletes completed 15 x 20m maximal sprints with a rapid deceleration, followed by eight sets of 10 plyometric jumps[81]. Upon completion of the protocol participants consumed 500 mL of milk (MILK) or 500 mL of an energy-matched carbohydrate (CHO) drink and recovery over 72h was monitored.

What were the main findings from your study?

No clear effect was observed on muscle soreness, nor serum Creatine Kinase or hsCRP. However, MILK had a very likely beneficial effect in attenuating losses in peak torque (180° /s) from baseline to 72 h (0.0 ± 10.0% vs. -8.7 ± 3.7%, MILK v CHO) (Figure 1), and countermovement jump (-1.1 ± 5.2% vs. -10.4 ± 6.7%) and symptoms of stress (-13.5 ± 7.4% vs. -18.7 ± 11.0%) from baseline to 24 h.

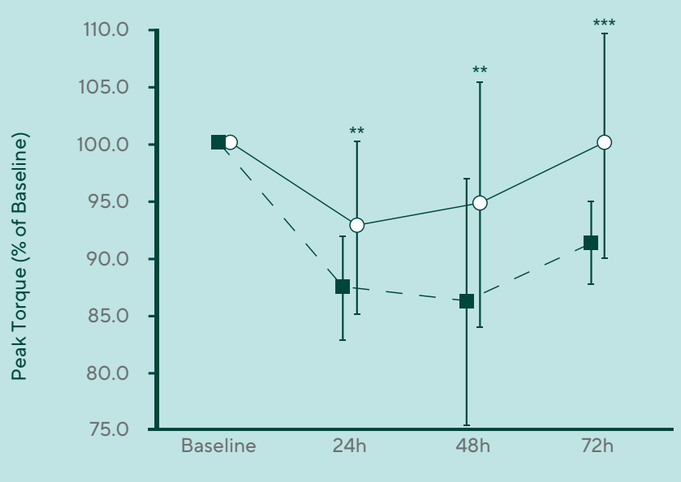

Figure 1.

Peak torque at 180°/s for dominant knee extension in response to repeated sprinting and jumping for MILK and CHO. Values are presented as means ± SD.
** Likely benefit of MILK.
***Very likely benefit of MILK.

- MILK
- CHO

What did you investigate next?

We then decided to explore the effects of milk on recovery from simulated team sport performance[82]. Twenty female team-sport athletes completed a circuit that was designed to simulate camogie and Gaelic football match play (2x ~ 30min, with 10 min 'half-time'), incorporating repeated sprints and jumps interspersed with periods of walking, jogging, running. Measures of muscle function, soreness and tiredness, symptoms of stress and serum markers of muscle damage and oxidative stress were determined pre- and 24 h, 48 h, 72 h and 96 h following the circuit. At 48 h, a second match simulation was completed.

Results showed that post-exercise consumption of milk had a beneficial effect in attenuating losses in peak torque for knee extension (60/s) (likely; effect size (ES)= 0.26 to 0.28) knee flexion (60/s) (likely; ES = 0.45 to 0.61). A benefit for milk was observed for 5 m sprint (possible-likely; ES = 0.40 to 0.58), 10 m sprint (likely; ES = 0.30 to 0.53) and symptoms of stress (likely–very likely).

What does this mean for athletes?

Practically, the results indicate, for female athletes at least, that 500ml of milk, providing 17.5g protein, is an effective recovery drink from varying types of exercise. The positive effects of milk have been attributed to a positive protein balance following the consumption of milk, a result of an increase in protein synthesis and a decrease in protein breakdown[93,94]. This information is of value to athletes and coaches who aim to maximise the recovery process following exercise, and especially when the recovery period is short.

"We see milk as the complete nutrient package. It contains carbohydrate, fats and proteins and a range of minerals and vitamins that are important not only for health, but for benefitting the recovery phase as well. So for example, in terms of rehydrating, milk contains sodium which helps to retain fluid. But also the fat and protein content in milk gives a really nice sustained delivery of fluid to the intestine, which enhances rehydration then over the longer recovery period.

And of course the protein content in milk is really important for enhancing protein synthesis following exercise, so that upon the consumption of milk we tend to see an increase in muscle protein synthesis which is beneficial for recovery of muscle function during the recovery period and also possibly can slow down or prevent the breakdown of muscle tissue in the secondary phase of muscle damage as well."

-Dr Paula Rankin

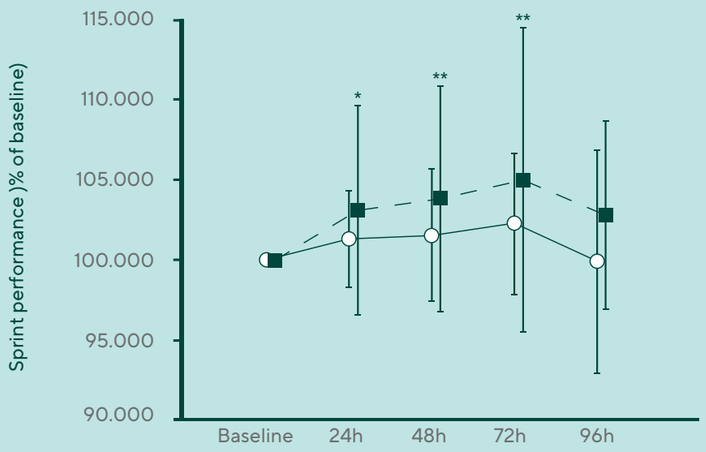

Figure 2.

5m sprint performance in response to repeated simulated team sport games (following Baseline and 48h measures). Values are presented as means ± SD.
*Possible benefit of MILK.
**Likely benefit of MILK.

Useful Resources

Sports Nutrition Handbook – Fuelling Wise for Sport and Exercise

The National Dairy Council has produced a Sports Nutrition Handbook for consumers, covering topics such as: body weight; carbohydrate; protein; fat; recovery nutrition; hydration; supplements; and the role of milk as part of an active lifestyle.

This booklet is endorsed by the Sport Ireland Institute and can be downloaded from: www.ndc.ie/nutrition/sports-nutrition; or free copies can be ordered by contacting publications@ndc.ie

Nutrition & You: Eating Sustainably

Ireland is among the best places internationally for sustainable milk production, with Irish dairy farms having one of the lowest carbon footprints in the world. This is because our mild, wet climate makes grass one of the most successful crops in Ireland, meaning grass- based dairy farming is a very reliable method of food production.

The National Dairy Council has produced a booklet on Eating Sustainably, which outlines key principles on this topic and the role of dairy as part of healthy, sustainable diets. It is endorsed by the Irish Nutrition and Dietetic Institute and Healthy Ireland and can be downloaded from: www.ndc.ie/publications; or free copies can be ordered by contacting publications@ndc.ie

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