Does consuming unflavoured milk effectively attenuate muscle damage after strenuous exercise?

Arthur Dunne, St Mary`s University Twickenham.

+353-87-6651542

Arthurwd@gmail.com

Ethical approval was granted by St Marys University ethical committee. Written informed consent was obtained from each participant prior to testing commencing.

The study was conducted as a final year research project with financial support from the School of Sport, Health and Applied Science Nutrition Programme at St Mary`s University.

**Key Words:** carbohydrate, protein, milk, muscle damage, recovery, serum creatine-kinase.

**ABSTRACT**

Research into flavoured milk has found positive effects at limiting muscle damage whereas the understanding of the effect of unflavoured milk in sports recovery is not as recognised. The aim was to determine whether unflavoured milk is as effective as commercially available flavoured milk at attenuating markers of muscle damage after exercised induced muscle damage (EIMD). The randomised-crossover design used nine male Gaelic football players who consumed 510ml of control, semi-skimmed milk (milk) or chocolate milkshake (choc) immediately after EIMD. Collection of blood samples for serum creatine-kinase analysis and assessment of DOMS were measured at baseline, 24 and 48 hours after EIMD. Results found a significant difference between conditions although post-hoc analysis could not identify which beverage influenced the greatest effect on limiting muscle damage. Post-exercise milk provided a similar attenuation in muscle damage compared to choc suggesting the reduced calories and low cost of milk is a beneficial muscle recovery beverage for lactose tolerant athletes.
INTRODUCTION

Optimising recovery for the modern athlete after exercise is an important challenge as it ensures full adaption to training and affects subsequent performance (Burke and Deakin, 2010; Rowlands et al., 2007). A growing body of scientific research supports the use of flavoured milk (FM) particularly chocolate milkshake as an exercise beverage for recovery and rehydration strategies (Roy, 2008; Pritchett and Pritchett 2012; Thomas, Morris, and Stevenson, 2009; Spaccarotella, and Andzel, 2011). By contrast research into the use of unflavoured milk (milk) as a beverage for muscle damage recovery is less documented. However emerging research has begun to support milk as a rehydration beverage and studies have also suggested potential benefit for recovery from exercise-induced muscle damage (EIMD) (Sheriffs, Watson and Maughan, 2007; Cockburn et al., 2008).

The calorie content of each beverage varies in that FM contains a greater concentration of carbohydrates while milk generally has a larger fat percentage which may cause alterations in recovery of muscle damage. Lactose is the natural carbohydrate found in milk whereas FM contains added sugars such as sucrose, fructose and glucose which may stimulate an increased insulin response thus positively affecting protein uptake and muscle recovery (Roy, 2008; Haug, Høstmark and Harstad, 2007). The only known studies to investigate the comparison of milk and FM in resistance exercise recovery were those conducted by Cockburn and colleagues in Northumbria. The studies contained methodological limitations as they were a non-crossover design which would have controlled confounding factors such as a high protein diet. Also the milk used in the FM was ultra-heat treated which has been found to have an altered nutritional value compared to fresh milk. The long shelf life milk is believed to contain products that render protein less digestible while also having a reduced number of fat soluble vitamins and antioxidants (Haug, Høstmark and Harstad, 2007; Lacroix et al., 2008).

The aim of the study was to determine whether or not milk is as effective as commercially available FM in attenuating markers of muscle damage 24 and 48 hours post-resistance exercise.

Method

Study Design

Each participant completed three experimental trials of EIMD followed by immediate beverage consumption of randomly assigned control (water), semi-skimmed milk (milk) or chocolate milkshake (choc) . Two hours before exercise collection of a baseline capillary blood sample for serum creatine-kinase (CK) analysis and subjective rating of muscle soreness were collected. Following EIMD participants immediately consumed 510ml of the allocated beverage. Post-exercise blood collection and perception of delayed onset of muscular soreness were measured 24 and 48 hours later.
**Nutritional Supplement**

The milk and choc supplements were both from freshly sourced cow’s milk (see table 1 for nutritional content). Participants consumed an isonitrogenous serving of 510ml as this volume has previously demonstrated its ability to significantly attenuate markers of muscle damage (Cockburn et al., 2010). As the choc was only commercially available as 471ml it was diluted with 39ml of water to eliminate dehydration as a factor for muscle soreness.

<table>
<thead>
<tr>
<th></th>
<th>Choc (Friji, Dairy Crest, Telford, UK)</th>
<th>Milk (Tesco, Tesco Stores Ltd, Cheshunt, UK).</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100ml</td>
<td>510ml</td>
</tr>
<tr>
<td></td>
<td>100ml</td>
<td>510ml</td>
</tr>
<tr>
<td>Energy (Kcal)</td>
<td>78</td>
<td>367</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>255</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>3.9</td>
<td>18.3</td>
</tr>
<tr>
<td></td>
<td>3.6</td>
<td>18.4</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>12.6</td>
<td>59.2</td>
</tr>
<tr>
<td></td>
<td>4.8</td>
<td>24.5</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>1.2</td>
<td>5.6</td>
</tr>
<tr>
<td></td>
<td>1.8</td>
<td>9.2</td>
</tr>
</tbody>
</table>

**Muscle-damaging exercise**

Muscle damage was induced in the lower half of the body using a box drop jump protocol similar to Miyama & Nosaka (2004).

**Participants**

Nine male Gaelic football players competing at British University championship level (age 22 ± 2 years; height 181.00 ± 6.91 cm; mass 78.19 ± 6.11 kg) volunteered to take part in this study. Gaelic football involves high-eccentric muscle actions throughout enduring game play, including fielding, kicking and short distance bursts for possession and evasion. Such repetitive and high-intensity muscle activity can cause large increases in muscle degradation (Spencer et al., 2005; Twist and Eston, 2005).

**Measures of muscle damage**

**Delayed onset muscle soreness (DOMS)**

A measurement of subject’s degree of active DOMS during a 90° squat (DOMS-SQ) movement was recorded as previously used for indices of muscle damage by Goodall and Howatson (2008).
Blood sample collection and analysis

Serum CK concentrations were measured from blood samples collected via a capillary puncture of the finger tip. Serum CK samples were stored and analysed one week after completion of the trials using the RX Monza.

Results and Discussion

Measures of muscle damage

![Graph showing serum CK concentrations over time for different conditions.]

Figure 1. The mean serum CK (U/L) values for control, milk and Choc at baseline, 24 and 48 hours after EIMD.

Table 2: Relative percentage change of serum CK for each condition from baseline to 24 and 48 hours post-exercise.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Baseline to 24 hours</th>
<th>Baseline to 48 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water (%)</td>
<td>5.04</td>
<td>34.49</td>
</tr>
<tr>
<td>Milk (%)</td>
<td>15.75</td>
<td>-28.60</td>
</tr>
<tr>
<td>Choc (%)</td>
<td>28.36</td>
<td>-33.10</td>
</tr>
</tbody>
</table>
The aim of the study was to investigate whether milk is as effective as FM in attenuating markers of muscle damage post resistance exercise. Results indicated that there was a significant difference between the milk based beverages and control at attenuating markers of CK and DOMS-SQ. However further post-hoc analysis could not identify which beverage had the greatest effect on reducing muscle damage and soreness over the 48 hours. In spite of this a clear trend can be seen in figure 1 which illustrates milk and choc were more favourable than the control at blunting muscle damage over the time period. Research supports the combined consumption of carbohydrates and protein in the attenuation of muscle damage post-resistance exercise (Burke and Deakin, 2010; Ivy et al., 2004; Roy, 2008; Cockburn et al., 2008; Baty et al., 2007). This may be because carbohydrates create the desired environment of augmented insulin concentrations with the addition of protein increasing amino acid availability that subsequently increases net muscle protein balance.

As with research by Cockburn et al. (2008) the milk beverages differed in carbohydrate content with the FM containing an estimated 2.4 times more carbohydrates then the unflavoured milk beverage. With increased carbohydrates there may have been an increased protein synthesis as there would have been greater insulin concentrations. However as
suggested by Cockburn et al. (2008) there may have been a ceiling effect to the carbohydrate content therefore resulting in a similar response in protein syntheses in both milk products. Furthermore the carbohydrates in the milk supplements had varying glycaemic index values which may have also influenced insulin response. The fat content of the milk supplements also differed with milk containing an extra 3g which, although in moderate amounts has no negative health effects, it may have altered the digestion of protein causing a reduced availability of amino acids in the early stages of recovery and consequently resulting in a greater percentage increase in markers of muscle damage (Tipton and Wolke, 2004; Haug, Høstmark and Harstad, 2007). However, in the first 24 hours results indicated muscle damage was greater in the choc supplement by 12%. In spite of this choc appeared to have the greatest affect at attenuating muscle damage over the 48 hours which may be due to the higher calorie content. The superior energy density of FM may have stimulated an optimal response for net muscle protein synthesis (Tipton and Wolfe, 2004).

There was a significant difference of subjective ratings of DOMS-SQ between condition and time. Figure 2 shows a distinct trend of reduced muscle soreness for milk and choc when compared to control which appears to continually rise past the 48 hours. Results were not in agreement with previous research with Green et al. (2008) and Cockburn et al. (2008) reporting no significant difference in DOMS rating. As the box drop jump protocol was bilateral it may have induced greater muscle damage in the major muscle of the lower limb compared to Cockburn et al. (2008) who isolated the hamstring in unilateral knee contractions. Furthermore due to the repeated measures design participants may have become more familiar to the subjective rating of muscle soreness hence providing a greater account of symptoms for each beverage.

Therefore, the study found and is in agreement with Cockburn et al. (2008) that the milk and FM contain the essential combination of protein and carbohydrate in attenuating signs and symptoms of muscle damage 48 hours after eccentric exercise. This suggests when compared to FM supplements unflavoured milk is a safe and inexpensive beverage that contains the key nutrients for meeting muscle recovery requirements for positive training adaption and optimising fuel for subsequent performance (Cockburn et al., 2008). Thus current findings may be advantageous to lactose tolerant athletes in weight categorised sports or those on a restricting diet as milk contains fewer calories than FM. As milk is not only an important source of calcium for young athletes and those that may suffer from stress fractures it can
now be consumed as part of a recovery strategy after resistance based exercise (Burke and Deakin, 2010).

Participants were asked to maintain a habitual diet and although this was not strictly controlled as a confounding factor it may have been eliminated by the crossover design. The limitation to such a design particularly in eccentric EIMD is the learning or repeated bouts effect (McHugh et al., 1999). The participants repeated the same exercise three times over three consecutive weeks. The repeated bouts effect is whereby the same exercise results in reduced signs and symptoms of muscle damage. The specific mechanism is still unknown but three theories have been proposed in neural, mechanical and cellular to influence the effect (McHugh et al., 1999). For this reason participants may have adapted over the three weeks resulting in potential variation in blood CK levels (Warren, Lowe and Armstrong, 1999). A further study limitation was the absence of a muscle function marker which would have provided a means for calculating the magnitude and time-course of muscle injury (Warren, Lowe and Armstrong, 1999).

In conclusion consumption of milk and FM immediately after eccentric exercise limits the symptoms and markers of muscle damage in Gaelic football players. The combined nutrients of carbohydrate and protein found in milk and FM provide suitable recovery to meet requirements from strenuous exercise. The reduced calories, safety and low cost of milk could make it a beneficial recovery beverage for lactose tolerant athletes in weight restricted sports and those that partake in resistance based exercise. Further research using a crossover design and muscle function measures should look to establish whether varying fat concentrations of milk have an effect on muscle damage recovery.
References list


