The Influence of Bovine Colostrum Supplementation on Exercise Performance in Highly-Trained Cyclists
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Key Words. time to fatigue, time trial, ventilatory threshold, recovery

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Abstract
Purpose: The aim of this experiment was to investigate the influence of low dose bovine colostrum supplementation on exercise performance over a ten week period that included five days of high-intensity training (HIT). Methods: Over seven days of preliminary testing, 29 highly-trained male road cyclists completed a VO\textsubscript{2max} test (in which their ventilatory threshold was estimated), a time to fatigue test at 110% of ventilatory threshold and a 40-km time trial (TT\textsubscript{40}). Cyclists were then assigned to either a supplement [n=14, 10g/day bovine colostrum protein concentrate (CPC)] or a placebo group (n=15, 10g/day whey protein) and resumed their normal training. Following five weeks of supplementation, the cyclists returned to the laboratory to complete a second series of performance testing (week 7). They then underwent five consecutive days of HIT (week 8) followed by a further series of performance tests (week 9). Results: The influence of bovine CPC on TT\textsubscript{40} performance during normal training was unclear (week 7: 1 ± 3.1%, week 9: 0.1 ± 2.1%; mean ± 90% confidence limits). However, at the end of the HIT period bovine CPC supplementation, compared to the placebo, elicited a 1.9 ± 2.2% improvement from baseline in TT\textsubscript{40} performance, a 2.3 ± 6.0% increase in time trial intensity (% VO\textsubscript{2max}) and maintained TT\textsubscript{40} heart rate (2.5 ± 3.7%). In addition, bovine CPC supplementation prevented a decrease in ventilatory threshold following the HIT period (4.6 ± 4.6%). Conclusion: Low dose bovine CPC supplementation elicited improvements in TT\textsubscript{40} performance during a HIT period and maintained ventilatory threshold following five consecutive days of HIT.
INTRODUCTION
Colostrum is the first milk produced by mammals after parturition and contains high concentrations of growth and immune factors essential to the physiological maturation of the newborn. Growth factors in colostrum include insulin like growth factors and transforming growth factors and are believed to play an important role in the development of skeletal muscle, gastrointestinal differentiation, and cell repair. The importance of colostrum for human neonate immune system development is well recognised, and the presence of closely homologous bioactive components in bovine colostrum has led to the growing use of bovine colostrum in humans.

Limited research to date suggests that bovine colostrum supplementation enhances exercise performance and recovery. Bovine colostrum supplementation at 60g/day for eight weeks has been shown to improve repeat sprint performance, peak vertical jump power and peak cycle power, and peak running speed during a repeated bout of intense exercise. In addition, a 20g and 60g/day dose over eight weeks has been reported to improve cycle time trial performance. Whether a smaller and hence more economical dose can enhance exercise performance is yet to be established.

As bovine colostrum has been found to improve endurance cycling performance and enhance recovery from an acute exercise session, it may benefit athletes during consecutive days of high-intensity training (HIT) or competition where recovery between exercise sessions is limited. Periods of HIT among athletes have been associated with a reduction in exercise time to fatigue at 110% of anaerobic threshold, a decrease in submaximal exercise heart rate and a decrease in the anaerobic threshold. The influence of bovine colostrum on performance and recovery from consecutive HIT sessions over several days is yet to be investigated.

The primary aim of this investigation was to examine the influence of low dose (10g/day) bovine colostrum protein concentrate (CPC) supplementation on exercise performance in highly-trained cyclists during the athletes’ normal training and five days of HIT. We hypothesized that bovine CPC would improve exercise performance during both periods.
Methods

Subjects. Twenty-nine highly-trained, male road cyclists volunteered to participate in the present investigation (Table 1). They had been racing competitively for at least two seasons and had maintained consistent training volumes for at least two months prior to the study. Prior to acceptance into the study, the cyclists completed a medical history questionnaire and gave their written consent. The experimental protocol was approved by the Medical Research Ethics Committee at The University of Queensland.

Table 1. Athlete characteristics. Data are presented as means ± SD.

<table>
<thead>
<tr>
<th></th>
<th>Bovine CPC (n = 14)</th>
<th>Placebo (n = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>29 (7)</td>
<td>27 (6)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>75.1 (8.1)</td>
<td>77.6 (7.4)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>180.3 (5.2)</td>
<td>179.4 (4.1)</td>
</tr>
<tr>
<td>VO$_{2\text{max}}$ (ml·kg$^{-1}$·min$^{-1}$)</td>
<td>68.8 (4.7)</td>
<td>69.3 (5.8)</td>
</tr>
<tr>
<td>Peak Power Output (W)</td>
<td>446 (43)</td>
<td>461 (34)</td>
</tr>
<tr>
<td>Training Volume (km/wk)</td>
<td>463 (110)</td>
<td>422 (70)</td>
</tr>
</tbody>
</table>

Experimental overview. All testing was completed in the Exercise Physiology Laboratory at The University of Queensland. The investigation was double-blind and placebo controlled. Cyclists completed one week of familiarization testing that consisted of a VO$_{2\text{max}}$ test (in which their ventilatory threshold was estimated), a time to fatigue test at 110% of ventilatory threshold (TTF) and a 40-km time trial (TT$_{40}$). The tests were repeated the following week (in the same order) and the data from this week used as baseline measures (ie. VO$_{2\text{max}}$1, TTF1, TT$_{40}$1). Following five weeks of supplementation and regular training, cyclists returned to the laboratory to complete another series of performance tests (ie. VO$_{2\text{max}}$2, TTF2, TT$_{40}$2). At the start of week eight cyclists undertook five consecutive days of high-intensity training (HIT) (which included a 40-km time trial, ie. TT$_{40}$3); followed by a further series of performance tests in week nine (ie. VO$_{2\text{max}}$3, TTF3, TT$_{40}$4) and after two days of rest, cyclists completed a final TTF test (TTF$_{4}$) (see Figure 1). Cyclists avoided all strenuous physical activity for 24 hours prior to each of the tests.

Diet and training diary. During the trial cyclists completed a daily diary that sought information on training and quality of sleep, as well as daily food and fluid intake. Dietary records were analyzed using computer software (Foodworks, Xyris, Brisbane, Australia) that calculated daily average macro- and micronutrient intakes. Cyclists refrained from taking any dietary supplements one month prior to, and for the duration of the study. Training diaries provided information on total number of training kilometers and total training time per week. This was further expressed in five categories of training intensity (category 1: <75% ventilatory threshold; category 2: 75-85% ventilatory threshold; category 3: 85-95% ventilatory threshold; category 4: 95-105% ventilatory threshold; category 5: >105% ventilatory threshold).

VO$_{2\text{max}}$ test. Height (cm) and weight (kg) were measured when the cyclists first arrived at the laboratory. Then, following a warm-up up at a self-selected pace for 5 minutes, cyclists completed a progressive exercise test to fatigue as described in Laursen et al$^{12}$. The test commenced at an initial workload of 100 W; workload thereafter increased by 15 W (30 W·min$^{-1}$) until volitional fatigue. Oxygen consumption was calculated with an online data-acquisition and analysis program (South Australian Sports Institute, Adelaide, Australia). Ventilatory threshold was established during the VO$_{2\text{max}}$ test, and was defined as the point at which a first clear breakpoint in the VE/VCO$_2$ was observed$^{13}$.

Time to fatigue test. Following a self-selected warm up, cyclists rode an electronically-braked cycle ergometer at a power output corresponded to 110% of their ventilatory threshold until they were no longer
able to maintain pedal revolutions greater than 60 rpm. Performance time was blinded to the athlete during the TTF and revealed to them on completion of the test.

**Laboratory simulated 40-km time trial.** Cyclists were instructed to abstain from physical activity for 24 hours before each test and to arrive at the laboratory well hydrated and fasted (for a period of eight hours). The cyclists rode their own road bicycle mounted to a stationary windtrainer (Cateye – Cyclosimulator CS-1000) as described in Laursen *et al.* Performance time was blinded to the athlete during the TT$_{40}$ and revealed to them on completion of the ride. Cyclists were allowed to consume water *ad libitum* during exercise; intake was monitored and recorded. Expired air was collected for three minute periods at 5-km, 20-km and 35-km and heart rate was recorded every 15s (Vantage NV, Polar Instruments Inc., Finland).

**Supplements.** After baseline performance testing, cyclists were randomly assigned to one of two groups. Cyclists in one group ingested 10g whey protein (placebo) per day while cyclists in the other group ingested 10g Intact® bovine colostrum protein concentrate (CPC) (Numico Research Australia, South Australia) per day mixed with 50mL water and 100mL skim milk. The period of supplementation was eight weeks and one day and both cyclists and experimenters were blinded to the treatment. The composition of the various bovine colostrum supplements available differs widely. Most published trials relating to bovine colostrum supplementation in athletes have used Intact® CPC which is a standardized, low heat, low fat, low lactose colostrum powder containing 20% IgG and retains both casein and whey proteins.

**High-Intensity training.** Following the testing in week seven, cyclists completed five consecutive days of high-intensity training (HIT). All training sessions involved exercise at or above ventilatory threshold. The first day of HIT involved 20 x 1-minute efforts at peak power output with two minutes recovery at 50 watts in between each effort. Training on day two involved 60 minutes cycling at 100% ventilatory threshold (comparable to TT$_{40}$ intensity). Day three involved 12 x 30-second sprints at 175% of peak power output with 4.5 minutes cycling at 50 watts in between sprints. HIT on day four involved 30 minutes cycling at 80% of ventilatory threshold followed by 45 minutes at 100% of ventilatory threshold. On the final day of HIT, cyclists performed another TT$_{40}$ (TT$_{403}$).

**Statistical analysis.** All performance variables were log transformed to reduce non-uniformity of error. The effects of bovine CPC were expressed as the difference in the mean percent change between the bovine CPC and placebo groups. To determine if the true effect of bovine CPC was beneficial or harmful, the precision of estimate was expressed as 90% confidence limits. If the effect of benefit and harm were both greater than 5%, the true effect was expressed as unclear. The smallest worthwhile improvement for performance measures was calculated to be half the coefficient of variation for that measure. worthwhile improvements in physiological variables were considered as: TT$_{40}$ intensity (% VO$_2$ max), 5%; VT, 5%; peak power output, 1.8%; VO$_2$ max, 2.1%. Differences between groups for total training time, training kilometres, training intensity and nutrient intake were analysed with an 8 (week 3 to week 10) x 2 (group) ANOVA using SPSS version 10.0 for Windows (SPSS, Chicago, IL, USA). $P < 0.05$ was accepted as being statistically significant. When a significant main effect was found, differences between training weeks were determined using a Bonferroni post hoc analysis.
RESULTS
Total training kilometres, total training time and training intensity were not different between groups over the 10-week period ($P > 0.05$). Total training time (in minutes) spent in heart rate categories 4 and 5 significantly increased during the HIT period (week 8), for both the placebo (category 4: 190% ± 14%, $P < 0.01$; category 5: 75 ± 44%, $P < 0.03$) and bovine CPC groups (category 4: 160 ± 49%, $P < 0.001$; category 5: 81 ± 25%, $P < 0.001$) when compared to the same five-day training period for week 7.

The average energy and macronutrient intake of cyclists in the placebo group was similar to those of the bovine CPC group ($P > 0.05$). For the placebo group average daily macronutrient intake was: carbohydrate 56%, protein 20% and fat 24%; and energy was 10,673kJ. For the bovine CPC group average daily macronutrient intake was: carbohydrate 55%, protein 23% and fat 22%; and energy was 10,572kJ.

Compared to baseline (TT401), and relative to placebo, bovine CPC supplementation improved mean TT40 performance for all TT40 (TT402, TT403 and TT404) (Table 2). While the effect of bovine CPC on TT402 and TT404 was unclear (1.4 ± 2.5% and 2.7 ± 1.22%, respectively; mean ± confidence limits), supplementation provided a likely benefit for TT40 performance at the end of the HIT period (TT403 vs TT401) (1.7 ± 1.3%) (Figure 2). There was an even greater effect of bovine CPC on TT403 performance for cyclists performing baseline time trials faster than 54 mins (equivalent to National level 40-km time trial time18), with a mean 3.3 ± 2.3% difference between groups. This represented a very likely improvement in TT403 following bovine CPC supplementation with 0% chance of harm and 98% chance of benefit. Figure 2 shows that those who supplemented with bovine CPC, with the exception of four cyclists, either maintained or improved their TT40 performance following five consecutive days of HIT. While the bovine CPC group improved mean TT40 performance at the end of the HIT period, there were no differences between the placebo and bovine CPC group for TT404, which was faster than TT403 for both groups (placebo = -90 ± 45s; bovine CPC = -34 ± 32s). Heart rate during TT403 was reduced from TT402 for the placebo group, while bovine CPC provided a possible benefit to maintain TT40HR at the end of the HIT period (placebo = -3.23 ± 1.61%; bovine CPC = -0.26 ± 1.45%) (Table 2). Bovine CPC was also associated with a possible benefit (increase) in TT40 intensity, expressed as a percentage of VO2 max, following five weeks of supplementation (TT402) (4.4 ± 3.7%) and at the end of the HIT period (TT403) (3.6 ± 2.2%). Despite an increase in TT40 intensity in the placebo group at the end of the HIT period (2.7 ± 4.9%), TT40 performance was slower (3 ± 52s).
Table 2. Effect of bovine CPC (relative to placebo) on mean changes in performance and physiological variables over the experimental period.

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Mean Change (%)</th>
<th>Confidence Limits (%)</th>
<th>Chances That the True Effect Has Substantial Benefit (%)</th>
<th>Harm (%)</th>
<th>Practical Assessmenta</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT401 vs TT402</td>
<td>-1</td>
<td>3.1</td>
<td>59</td>
<td>18</td>
<td>unclear</td>
</tr>
<tr>
<td>TT401 vs TT403</td>
<td>-1.9</td>
<td>2.2</td>
<td>83</td>
<td>3</td>
<td>benefit likely</td>
</tr>
<tr>
<td>TT401 vs TT404</td>
<td>-0.1</td>
<td>2.1</td>
<td>29</td>
<td>32</td>
<td>unclear</td>
</tr>
<tr>
<td>TTF1 vs TTF2</td>
<td>-2.9</td>
<td>9.3</td>
<td>7</td>
<td>35</td>
<td>unclear</td>
</tr>
<tr>
<td>TTF1 vs TTF3</td>
<td>-0.04</td>
<td>12.7</td>
<td>23</td>
<td>26</td>
<td>unclear</td>
</tr>
<tr>
<td>TTF1 vs TTF4</td>
<td>-5.2</td>
<td>15.7</td>
<td>12</td>
<td>52</td>
<td>unclear</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physiological Variables</th>
<th>Mean Change (%)</th>
<th>Confidence Limits (%)</th>
<th>Chances That the True Effect Has Substantial Benefit (%)</th>
<th>Harm (%)</th>
<th>Practical Assessmenta</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT401 HR vs TT402 HR</td>
<td>0.4</td>
<td>3.5</td>
<td>11</td>
<td>5</td>
<td>unclear</td>
</tr>
<tr>
<td>TT401 HR vs TT403 HR</td>
<td>2.5</td>
<td>3.7</td>
<td>41</td>
<td>1</td>
<td>benefit possible</td>
</tr>
<tr>
<td>TT401 HR vs TT404 HR</td>
<td>0.6</td>
<td>2.8</td>
<td>8</td>
<td>2</td>
<td>benefit unlikely</td>
</tr>
<tr>
<td>TT401 VO2 vs TT402 VO2</td>
<td>5.2</td>
<td>5.8</td>
<td>52</td>
<td>0</td>
<td>benefit possible</td>
</tr>
<tr>
<td>TT401 VO2 vs TT403 VO2</td>
<td>2.3</td>
<td>6.8</td>
<td>22</td>
<td>2</td>
<td>benefit possible</td>
</tr>
<tr>
<td>TT401 VO2 vs TT404 VO2</td>
<td>-0.6</td>
<td>6.8</td>
<td>8</td>
<td>14</td>
<td>unclear</td>
</tr>
</tbody>
</table>

±90%CL: add and subtract this number to the mean effect to obtain the 90% confidence limits for the true difference. TT40 = 40-km time trial, TTF = time to fatigue. TT401 was completed at baseline (prior to the supplementation period); TT402 performed following 5 weeks of supplementation, TT403 was performed on the last of the five consecutive day of HIT and TT404 was performed during the last week of performance testing (week 10).

a Qualitative analysis of effects that were beneficial or harmful were assessed as: <1%, almost certainly not; 1-5% very unlikely; 5-25%, unlikely; 25-75%, possible; 75-95%, likely; 95-99%, very likely; >99% almost certain.

Both the placebo and bovine CPC groups experienced an increase in TTF from baseline (TTF1) to week 10 (TTF4) (placebo: TTF1 = 416 ± 83s, TTF4 = 491 ± 129s; bovine CPC: TTF1 = 455 ± 133s, TTF4 = 504 ± 163s). The effect of a 10g/day dose of bovine CPC on TTF performance, however, was unclear (Table 2).

The influence of bovine CPC supplementation on VO2_max and peak power output over the experimental period was trivial (Table 3). However, bovine CPC provided a possible benefit to maintain ventilatory threshold three to four days following the HIT period (3.6 ± 5.9%). The placebo group experienced a mean 14.6% (± 19.2%) decrease in ventilatory threshold while the bovine CPC group experienced a mean 2.2% increase (± 15.7%) (Table 3).
Table 3. VO$_2$ max, peak power output (PPO) and ventilatory threshold (VT) over the experimental period.

<table>
<thead>
<tr>
<th></th>
<th>VO$_2$ max 1 Test</th>
<th>VO$_2$ max 2 Test</th>
<th>VO$_2$ max 3 Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bovine CPC</td>
<td>Placebo</td>
<td>Bovine CPC</td>
</tr>
<tr>
<td>VO$_2$ max (L·min)</td>
<td>4.94 (0.52)</td>
<td>5.22 (0.4)</td>
<td>4.99 (0.65)</td>
</tr>
<tr>
<td>PPO (watts)</td>
<td>442 (36)</td>
<td>455 (27)</td>
<td>445 (40)</td>
</tr>
<tr>
<td>VT (L·min)</td>
<td>4.13 (0.42)</td>
<td>4.48 (0.47)</td>
<td>4.10 (0.55)$^#$</td>
</tr>
</tbody>
</table>

Data are presented as means (SD). $^\#$Possible benefit of bovine CPC from baseline to week 8. $^\dagger$ Possible benefit of bovine CPC from week 8 to week 10.
DISCUSSION
The present data show that low dose bovine CPC supplementation provides a worthwhile improvement in 40-km time trial (TT₄₀) performance following a period of HIT. In addition, there was a possible benefit of bovine CPC to enhance TT₄₀ intensity and prevent a decrease in submaximal heart rate during HIT. Bovine CPC supplementation also provided a possible benefit to minimize fatigue and/or enhance recovery by maintaining ventilatory threshold three to four days following the HIT period.

Bovine CPC supplementation, when compared to the placebo, provided a likely benefit to TT₄₀ performance at the end of a five-day period of HIT. Improvements in time trial performance in already highly trained athletes following HIT are smaller than improvements in performance observed with untrained to moderately trained individuals following training¹⁹,²⁰. For highly trained athletes a worthwhile improvement in performance is considered to be half of the coefficient of variation for that measure¹⁶. The 1.65% improvement in TT₄₀ for the bovine CPC group following HIT can be considered a small, but worthwhile improvement as in our lab the coefficient of variation for TT₄₀ performance following familiarization is 0.9 ± 0.7%¹⁴.

The placebo group experienced a slight decrease in TT₄₀ performance from baseline, despite an increase in exercise intensity. Ronsen and colleagues²¹ have reported an increase in VO₂ at the same submaximal exercise intensity when cyclists are fatigued from a prior bout of exercise which may be the result of an increase in fat oxidation as a result of depleted muscle glycogen concentrations²¹. The placebo group also experienced a decrease in average TT₄₀ HR at the end of the HIT period which may indicate greater fatigue when compared to the bovine CPC group. Declines in submaximal HR have also been reported by Verde et al²² and Lehmann et al¹⁰ following a period of intensified training which has been associated with a decrease in performance.

Although the present data limit speculation as to the mechanism/s responsible for the improvements in TT₄₀ performance for the bovine CPC group at the end of a five-day HIT period, energy availability may have been enhanced. Increased muscle glycogen levels during normal training do not improve one hour cycling performance²³ or 45 minute cycling performance (at an average intensity of 82% VO₂ max)²⁴, however, during repeated days of high-intensity exercise enhanced muscle glycogen content may prevent and/or delay fatigue²⁵,²⁶. Research has previously found that colostrum feeding in newborn calves increases plasma glucose concentrations and is associated with enhanced gluconeogenesis rate limiting enzymes pyruvate carboxylase and phosphoenolpyruvate carboxykinase²⁷. Colostrum also contains IGF-1 which has been found to enhance glucose uptake by skeletal muscle, independent of changes in GLUT-4 protein²⁸. Whether bovine CPC improves muscle glycogen resynthesis during periods of intense training warrants investigation.

Research has previously found improvements in sprint and endurance running performance following bovine CPC supplementation at eight weeks, but not at four weeks⁶. Somewhat consistent with this, the present study found the influence of bovine CPC on TT₄₀ performance was unclear following five weeks of supplementation, during normal training. However, in contrast, the effect on TT₄₀ performance during normal training following eight weeks of supplementation was also unclear. The disparate findings of enhanced performance in our previous work⁷ and an unclear influence on TT₄₀ performance during normal training in the present study may be related to differences in the TT protocol used (2 hr and 2.8kJ/kg versus 40-km in the present study) and fasting state. It is also possible that the smaller dose (10g) of bovine CPC used in the present study may not have been sufficient to elicit the same improvements in performance during normal training periods as those reported by our group previously⁷. It remains to be seen if a 10g dose improves short duration (approximately 13 min) time trial performance following two hours of submaximal endurance performance.

The five consecutive days of HIT were sufficient to induce short-term fatigue in the placebo group, as evidenced by a decrease in ventilatory threshold. This is consistent with the findings of others¹¹,²⁸ and it remains to be determined how bovine CPC, as shown in the present study, prevented the same degree of fatigue following HIT period. Cyclists in both groups seemed to have recovered from any residual fatigue resulting from the HIT period in six to seven days; TT₄₀₃ performance for both groups during the final week was faster than the TT₄₀₃ completed at the end of the HIT period.
In contrast to the TT40 data, the influence of bovine CPC on TTF at 110% of the cyclists' ventilatory threshold was unclear. Both groups improved their TTF over the experimental period, however there were no differences between the bovine CPC and placebo group. Previous literature has suggested that time to fatigue is a more sensitive marker of fatigue or over reaching than changes in VO2max. We hypothesised that we would observe a decrease in TTF in the placebo group, compared to the bovine CPC, in the week following the HIT period. While the placebo group experienced a decrease in ventilatory threshold three to four days following the HIT period, TTF performance, five to six days following the HIT period, remained unchanged. Cyclists in the placebo group may have recovered from any residual fatigue from the HIT period within five to six days. It is also possible that the mechanism responsible for improved TT40 performance is not associated with improvements in shorter duration exercise above threshold.

In summary low dose bovine CPC supplementation was associated with a worthwhile improvement in TT40 performance and a reduction in fatigue following a five-day HIT period. In addition, compared to placebo data, bovine CPC supplementation prevented a decrease in ventilatory threshold three to four days following the HIT period. The mechanism(s) for the observed performance improvements and reduction in fatigue following bovine CPC supplementation remain to be determined.
ACKNOWLEDGEMENTS
We are grateful for the dedication and commitment of the cyclists who took part in the present study.

COMPETING INTERESTS
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Figures
Figure 1. Experimental overview. The first week of testing involved a VO₂max test, a 40-km time trial (TT₄₀) and a time to fatigue test at 110% of ventilatory threshold (TTF). These tests were repeated in weeks seven and nine. Following five weeks of normal training (weeks two to six) and one week of repeat testing (week seven), cyclists performed five consecutive days of high-intensity training (HIT) that included a TT₄₀ on the fifth day (TT₄₀₃). After the final week of testing (week nine), cyclists performed a final TTF test (week 10).

Figure 2. Individual change in TT₄₀₃ performance from baseline. TT₄₀₁ was completed at baseline (prior to the supplementation period) while TT₄₀₃ was performed on the last of the five consecutive days of HIT.
REFERENCES

What is already known on this topic:

Bovine colostrum supplementation at 60g/day enhances repeat running and cycling performance during normal training periods.

What this study adds:

Bovine colostrum supplementation at 10g/day enhances cycling performance during, and prevents a decrease in ventilatory threshold following a period of high-intensity training.
Figure 1.
Figure 2.