SCIENCE IN SPORT

PERFORMANCE TESTED: SODIUM ALGINATE

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INTRODUCTION

This trial was completed externally at the Porsche Human Performance Laboratory under the supervision of Jack Wilson (PHPL) and Dr Robert Child (SiS)

This report of data analysis, presentation and interpretation was compiled by Dr Tom Brownlee and Professor James Morton (both affiliated to SiS and LJMU)

AIM

To test the hypothesis that inclusion of sodium alginate in a dual source CHO sports drink (Maurten Drink Mix 320) improves cycling performance to a greater extent than than that occurring with a dual source isotonic CHO sports drink alone (SiS Beta Fuel).

METHODOLOGICAL OVERVIEW

TEST SUBJECTS

	n=14	Range (min-max)
Age (years)	34 ± 9	18-45
Body Mass (kg)	77.2 ± 9.6	57.6-91.9
Height (cm)	182 ± 4	173-187
VO_{2peak} (ml/kg/min)	60.2 ± 4.6	51-66
VO_{2peak} (L/min)	4.6 ± 0.5	3.51-5.75
Peak Power Output (W)	400 ± 40	325-475
Lactate Threshold (W)	222 ± 20	185-255
Lactate Threshold (%VO_{2peak})	70 ± 6	63-81

EXPERIMENTAL DESIGN

Having been initially assessed for maximal oxygen uptake and lactate threshold and using a randomised repeated measures design,14 male amateur cyclists and triathletes completed 2 h of steady state cycling (at 90 % of lactate threshold) under 3 test conditions during which they consumed 83 or 80 g of CHO per hour (from two commercially available solutions of Maurten Drink Mix 320 versus SiS Beta Fuel, respectively) or a non-caloric placebo solution.

All subjects commenced the 2 h cycling protocol after adhering to a 36 h CHO loading feeding strategy (where CHO was consumed at an absolute amount corresponding to 12 g/kg body mass during the 36 h period after completing a prior glycogen depleting exercise protocol of Impey et al. 2016) and a pre-exercise CHO rich meal (1 g/kg body mass) consumed at 1.5 h before exercise. Following completion of the 2 h steady state protocol, subjects then performed a time trial performance test where they were required to complete a set workload (25 % of the workload completed during the 2 h steady state cycling protocol) as fast as possible.

All cycling tests were completed on an electrically braked cycle ergometer (SRM, Amtzell, Germany). Heart rate (Polar Kempele, Finland), ratings of perceived exertion (RPE, Borg 1970), measurements of capillary blood glucose (CardioChek PA, Indianapolis, USA), capillary blood lactate (Lactate Pro, Japan) and whole body rates of oxygen uptake (Metalyser Cortex 3B) were obtained at 10-15 minute intervals during exercise.

Rates of CHO and lipid oxidation were quantified according to the equations of Jeukendrup and Wallis (2005). Ratings of gastrointestinal discomfort were also assessed at 10 minute intervals during the 2 h steady state cycling protocol to assess incidences of severe and non-severe symptoms according to the questionnaire of Jentjens et al. (2004).

TEST DRINKS

During the 2 h steady state cycling protocol, subjects consumed 125 ml of Maurten (Maurten Drink Mix 320, Gothenburg, Sweden), Beta Fuel (Science in Sport, Nelson, UK) or a non-caloric Placebo solution (taste matched to the Beta Fuel solution and manufactured by SiS) after 15, 30, 45, 60, 75, 90, 105 and 120 minutes of exercise.

In this way, subjects consumed a total of 166 and 160 g CHO in the Maurten and Beta Fuel trials, respectively, and fluid consumption was matched in all 3 trials and corresponded to 1000 ml.

Table 1 - Overview of nutritional breakdown of the Maurten and Beta Fuel test drinks. Values are representative of 500 ml of test solution. *nutritional analysis of Maurten was performed in an external laboratory (Camden BRI, UK).

	MAURTEN	BETA FUEL	PLACEBO
TOTAL CHO (g)	83	80	0
MALTODEXTRIN (g)	49	56	0
FRUCTOSE (g)	34	26	0
SODIUM (mg)	200	229	0
pH	3.8	6.2	3.3
SODIUM ALGINATE (g)	1	0	0
OSMOLALITY (mOsmol/L)	450	320	0

STATISTICAL ANALYSIS

All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS Version 24).

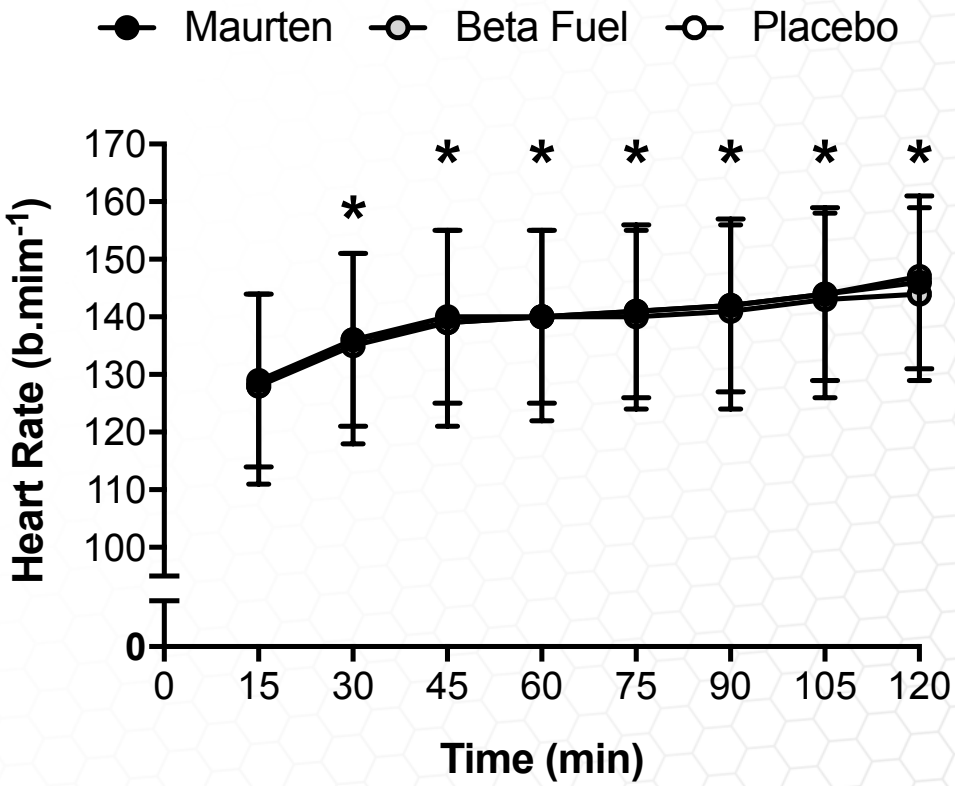
Comparison of time trial performance and mean power output during the time trial were analysed using a one-way repeated-measures general linear model whereas changes in physiological and metabolic responses between trials (i.e. heart rate, RPE, blood glucose, blood lactate and substrate metabolism) were analysed using a two-way repeated measures general linear model, where the within factors were time and condition. Where a significant main effect was observed, pairwise comparisons were analysed according to Least Significant Differences post-hoc tests in order to locate specific differences.

All data in text, figures and tables are presented as means ± SD with P values ≤ 0.05 indicating statistical significance.

PHYSIOLOGICAL RESPONSES TO 2 h STEADY STATE EXERCISE AT 90 % LACTATE THRESHOLD

STATISTICAL ANALYSIS

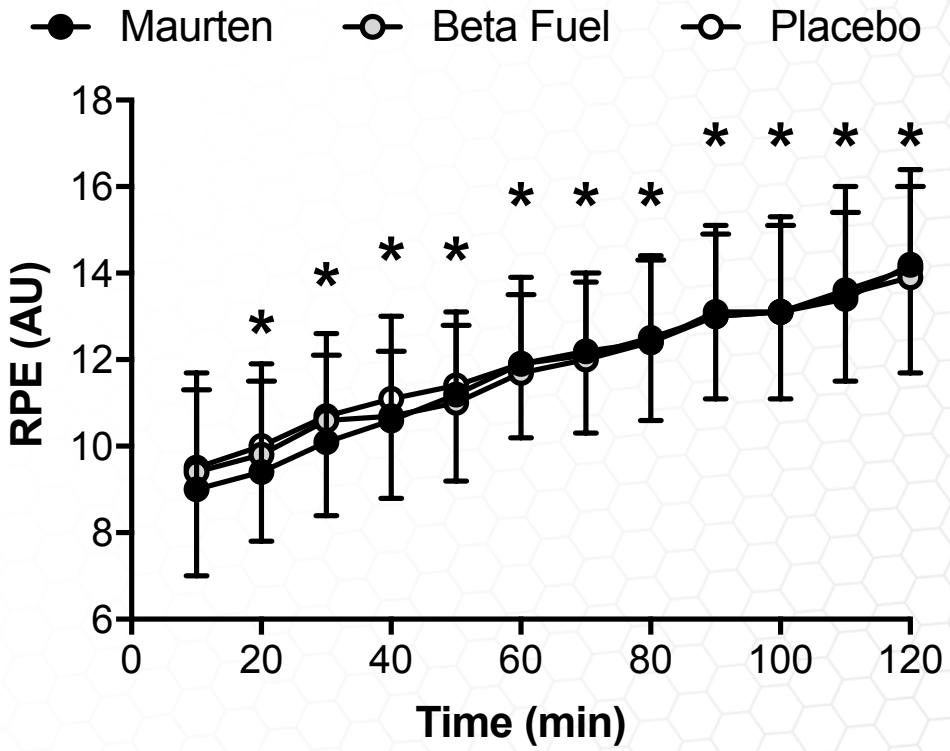
The average workload completed during the 2 h steady state protocol corresponded to 1582 ± 149 kJ. Heart rate significantly increased during exercise ($P < 0.01$) though there was no significant difference between trials ($P = 0.72$). These data demonstrate that the cardiovascular strain during exercise was similar between trials.



* denotes significant difference from 15 minutes, $P < 0.05$.

STATISTICAL ANALYSIS

Ratings of perceived exertion (RPE) significantly increased during exercise ($P < 0.01$) though there was no significant difference between trials ($P = 0.71$). These data demonstrate that the perceptual stress of exercise was similar between trials.

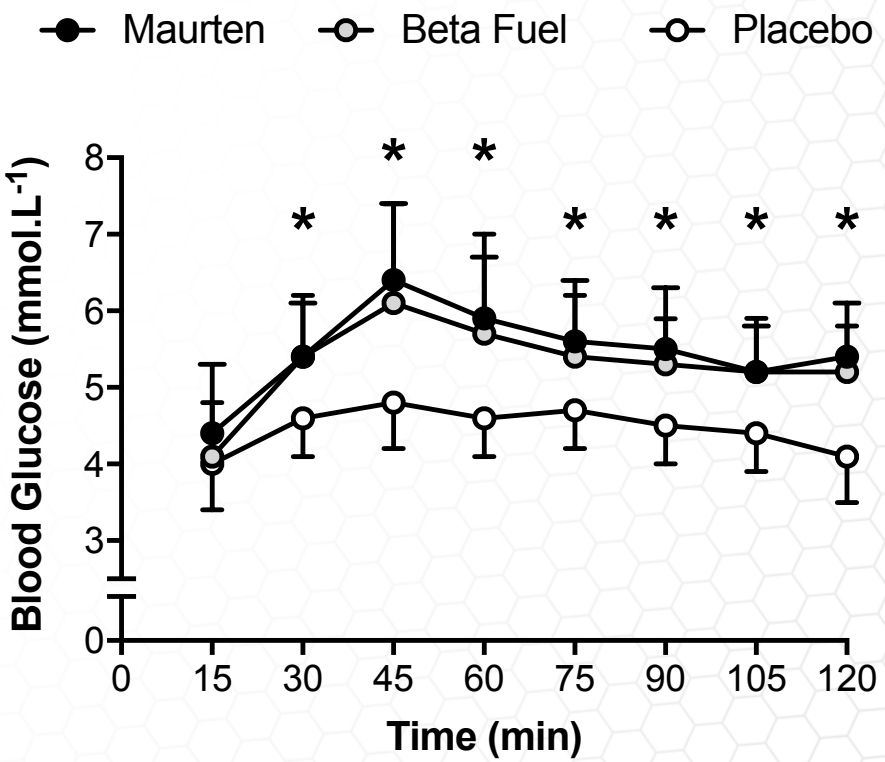


* denotes significant difference from 10 minutes, $P < 0.05$.

BLOOD GLUCOSE RESPONSES TO 2 h STEADY STATE EXERCISE AT 90 % OF LACTATE THRESHOLD

STATISTICAL ANALYSIS

Blood glucose significantly increased during exercise (P < 0.01) and there was also a significant difference between trials (P < 0.01 for both trial and time x trial interaction effect). Both Maurten (P < 0.01, 95 % CI: 0.82-1.2 mmol/L) and Beta Fuel (P < 0.01, 95 % CI: 0.5-1.2 mmol/L) were significantly different from Placebo though no differences were apparent between Maurten and Beta Fuel (P = 0.22, 95 % CI: -0.1-0.5 mmol/L).

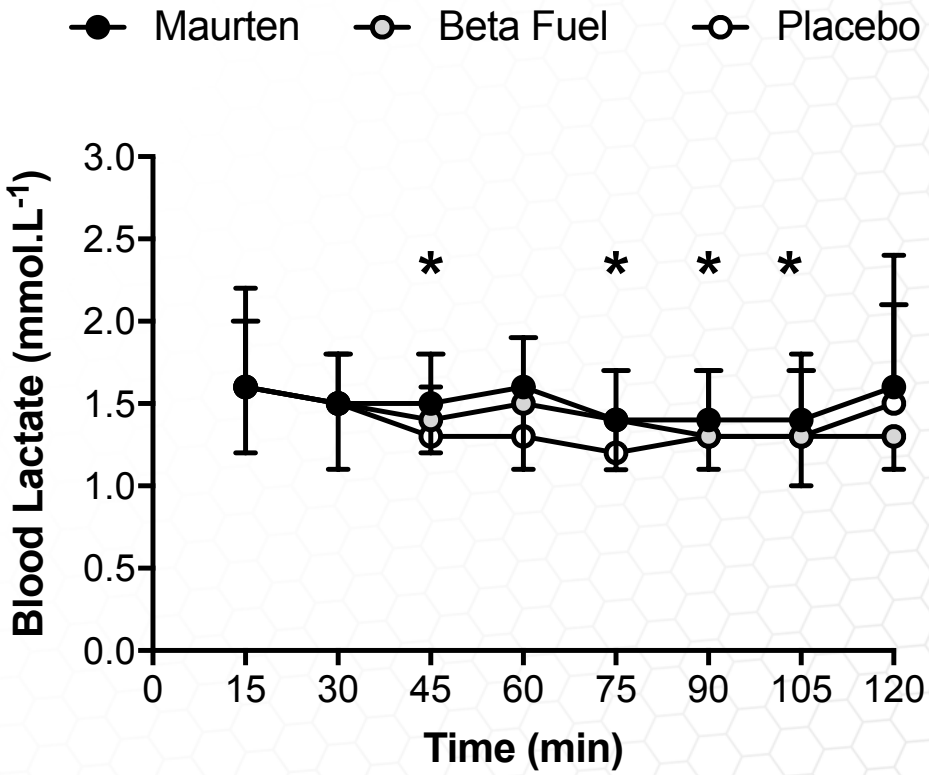


* denotes significant difference from 15 minutes, P < 0.05.

BLOOD LACTATE RESPONSES TO 2 h STEADY STATE EXERCISE AT 90 % OF LACTATE THRESHOLD

STATISTICAL ANALYSIS

Blood lactate concentration significantly changed during exercise (P = 0.013) though there was no significant difference between trials (P = 0.71).

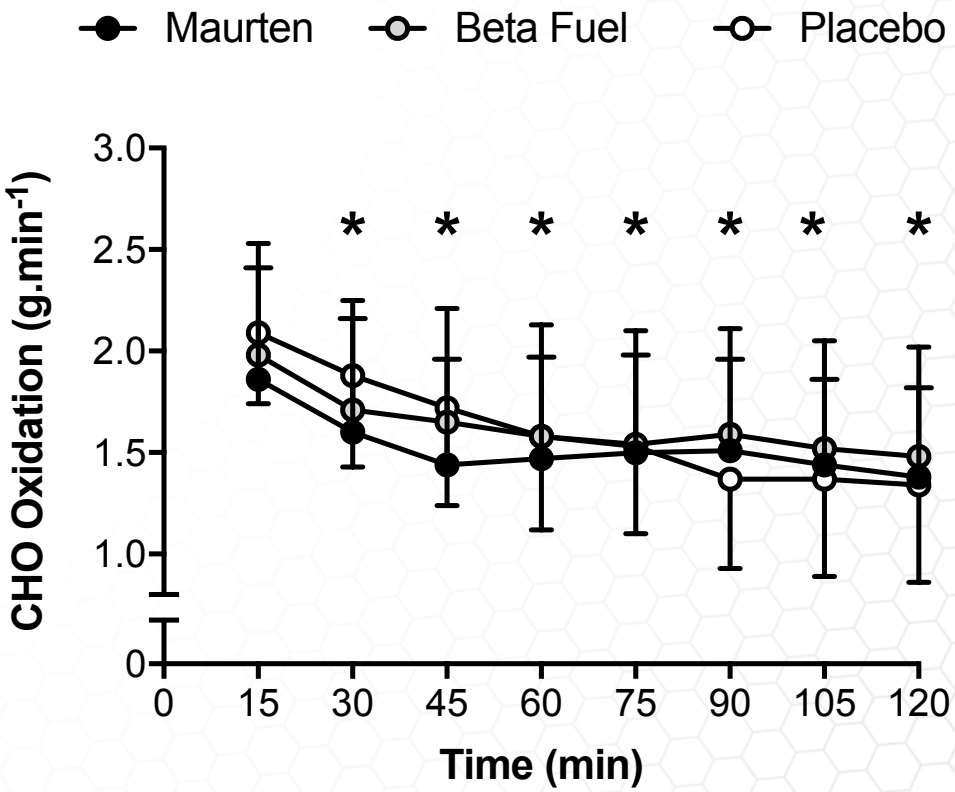


* denotes significant difference from 15 minutes, P < 0.05.

SUBSTRATE OXIDATION DURING 2 h STEADY STATE EXERCISE AT 90 % OF LACTATE THRESHOLD

STATISTICAL ANALYSIS

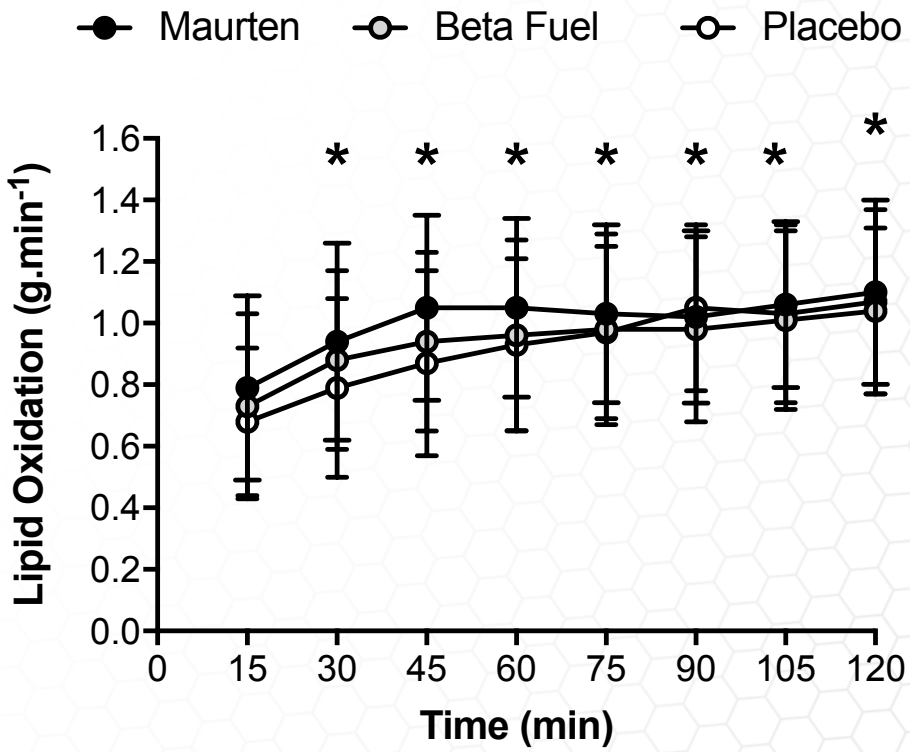
CHO oxidation significantly decreased during exercise (P < 0.01) and there was also a significant time x trial interaction effect (P < 0.01) such that the rate of decrease in CHO oxidation was greatest in the Placebo trial.



* denotes significant difference from 15 minutes, P < 0.05.

STATISTICAL ANALYSIS

Fat oxidation significantly increased during exercise (P < 0.01) and there was also a significant time x trial interaction effect (P < 0.01) such that the rate of increase in fat oxidation was greatest in the Placebo trial.



* denotes significant difference from 15 minutes, P < 0.05.

GASTROINTESTINAL DISCOMFORT

STATISTICAL ANALYSIS

There were no apparent differences in the incidence of severe GI symptoms reported during each trial (symptoms were considered severe when rating for each parameter was > 5).

	Maurten	Beta Fuel	Placebo
Stomach Problems	0	0	1
Nausea	1	0	2
Urge to Vomit	0	1	2
Bloated Feelings	0	0	0
Stomach Cramps	0	0	0
TOTAL	**1**	**1**	**5**

STATISTICAL ANALYSIS

There were no apparent differences in the incidence of non-severe GI symptoms reported during each trial (symptoms were considered non-severe when rating for each parameter was < 5).

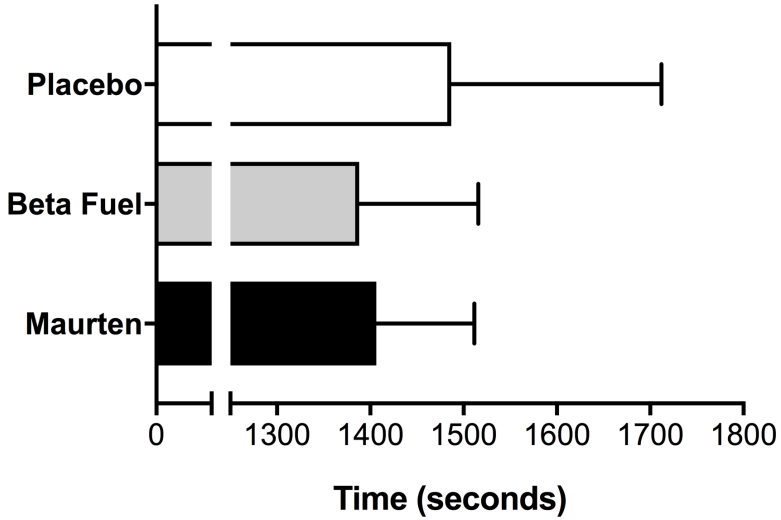
	Maurten	Beta Fuel	Placebo
Stomach Problems	4	4	1
Nausea	2	6	2
Urge to Vomit	4	1	1
Bloated Feelings	1	5	3
Stomach Cramps	3	3	2
Intestinal Cramps	0	1	4
Dizziness	5	6	4
Headache	1	0	1
Flatulence	1	0	1
Urge to Urinate	2	1	4
Urge to Defecate	0	1	0
Belching	4	2	5
Stomach Burn	3	3	2
Side Aches (left)	1	1	1
Side Aches (right)	1	2	2
Reflux	0	1	0
TOTAL	32	37	33

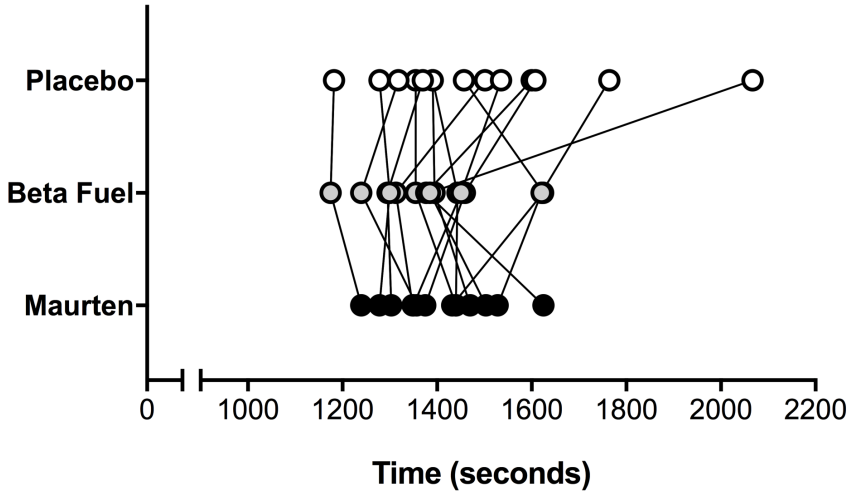
TT PERFORMANCE

TIME TAKEN TO COMPLETE 25 % OF THE TOTAL WORKLOAD COMPLETED DURING THE 2 h PRIOR STEADY STATE EXERCISE

STATISTICAL ANALYSIS

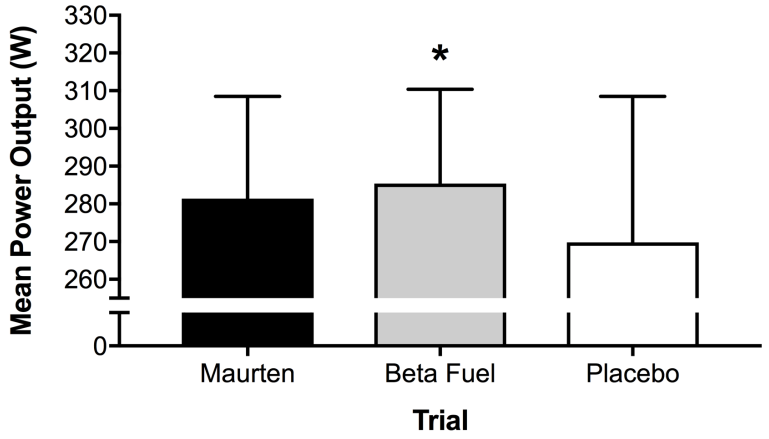
The average workload completed during the time trial protocol corresponded to 395 ± 37 kJ. Whilst not statistically significant, there was a tendency (P = 0.09) for the time taken to complete the time trial to be different between trials. Specifically, Maurten (23 min 26 sec ± 1 min 45 sec) was not significantly different from either the Beta Fuel (23 min 08 sec ± 2 min 00 sec: P = 0.55, mean difference = 18 seconds slower, 95 % CI, -47 to +83 seconds) or Placebo trials (24 min 47 sec ± 3 min 45 sec: P = 0.12, mean difference = 80 seconds faster, 95 % CI, -185 to +23 seconds). However, Beta Fuel tended to be faster than the Placebo trial (P = 0.08, mean difference = 99 seconds faster, 95 % CI, -213 to +15 seconds). When considering individual data, 7 subjects performed fastest in the Beta Fuel trial, 5 subjects performed fastest in the Maurten trial and 2 subjects performed fasted in the Placebo trial.

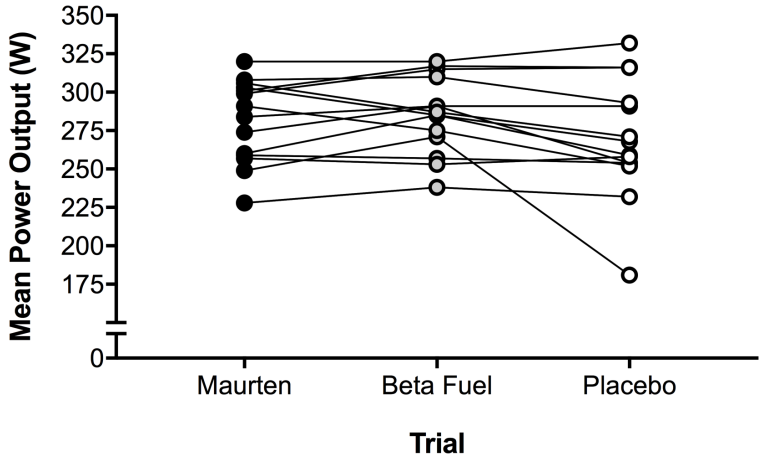




STATISTICAL ANALYSIS

Average power output during the time trial was significantly (P = 0.05) different between trials. Whilst Maurten (281 ± 27 W) was not significantly different from either the Beta Fuel (285 ± 25 W: P = 0.33, mean difference = - 4 W, 95 % CI, -13 to +4 W) or Placebo trials (270 ± 39 W: P = 0.14, mean difference = +11 W, 95 % CI, -4 to +27 W), average power output during the Beta Fuel trial was significantly higher than the Placebo trial (P = 0.04, mean difference = +15 W, 95 % CI, +1 to +30 W). When considering individual data, 7 subjects produced the highest power in the Beta Fuel trial, 4 produced the highest power in the Maurten trial and 3 subjects produced the highest power in the Placebo trial.

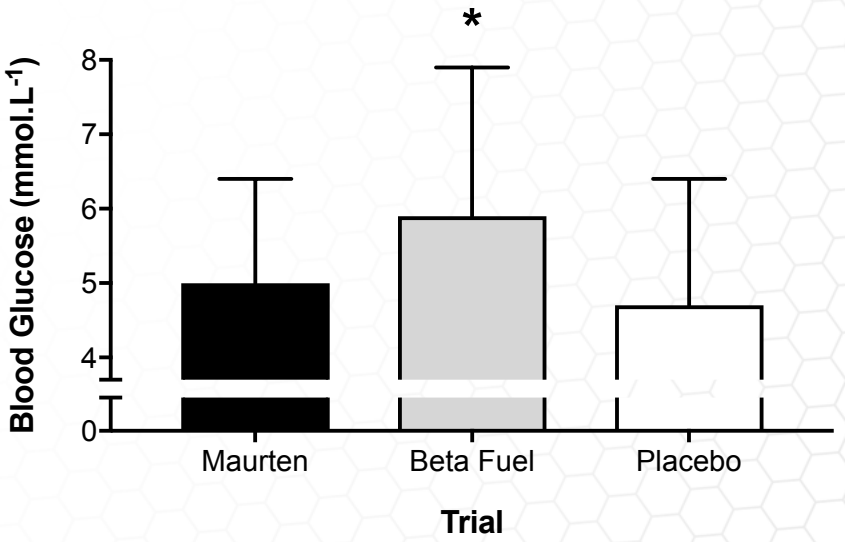




* denotes significant difference from Placebo, P < 0.05.

STATISTICAL ANALYSIS

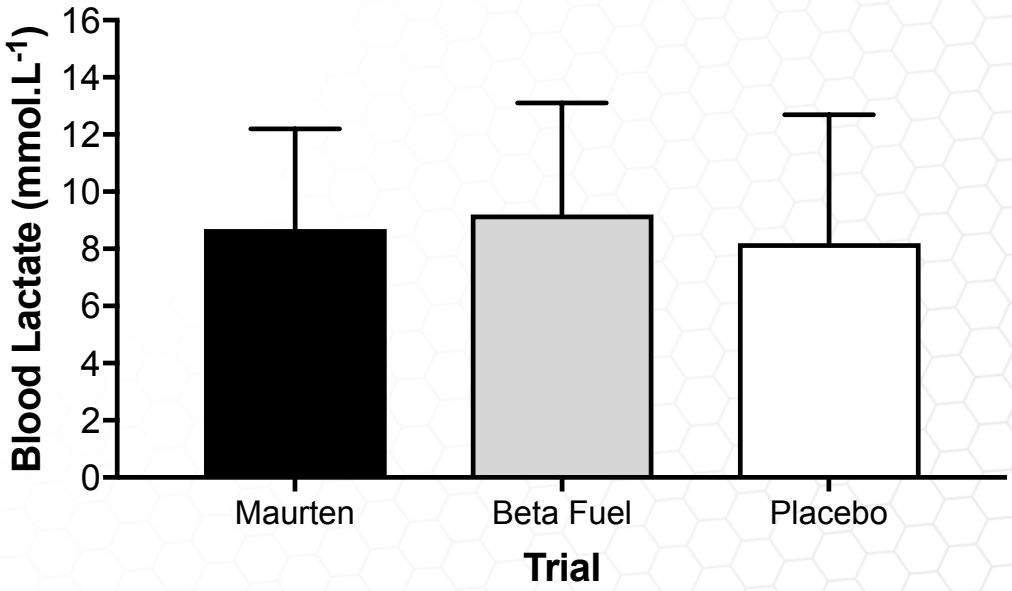
At the point of time trial completion, blood glucose concentration was significantly (P = 0.01) different between trials. Whilst Maurten (5.0 ± 1.4 mmol/L) was not significantly different from the Placebo trial (4.7 ± 1.7 mmol/L: P = 0.40, mean difference = +0.29 mmol/L, 95% CI, -0.44 to + 1.0 mmol/L), blood glucose was significantly higher in the Beta Fuel trial (5.9 ± 2.0 mmol/L) versus both the Placebo (P = 0.01, mean difference = +1.2 mmol/L, 95 % CI, -0.30 to + 1.99 mmol/L) and Maurten trials (P = 0.03, mean difference = +0.9 mmol/L, 95 % CI, -0.11 to + 1.59 mmol/L).

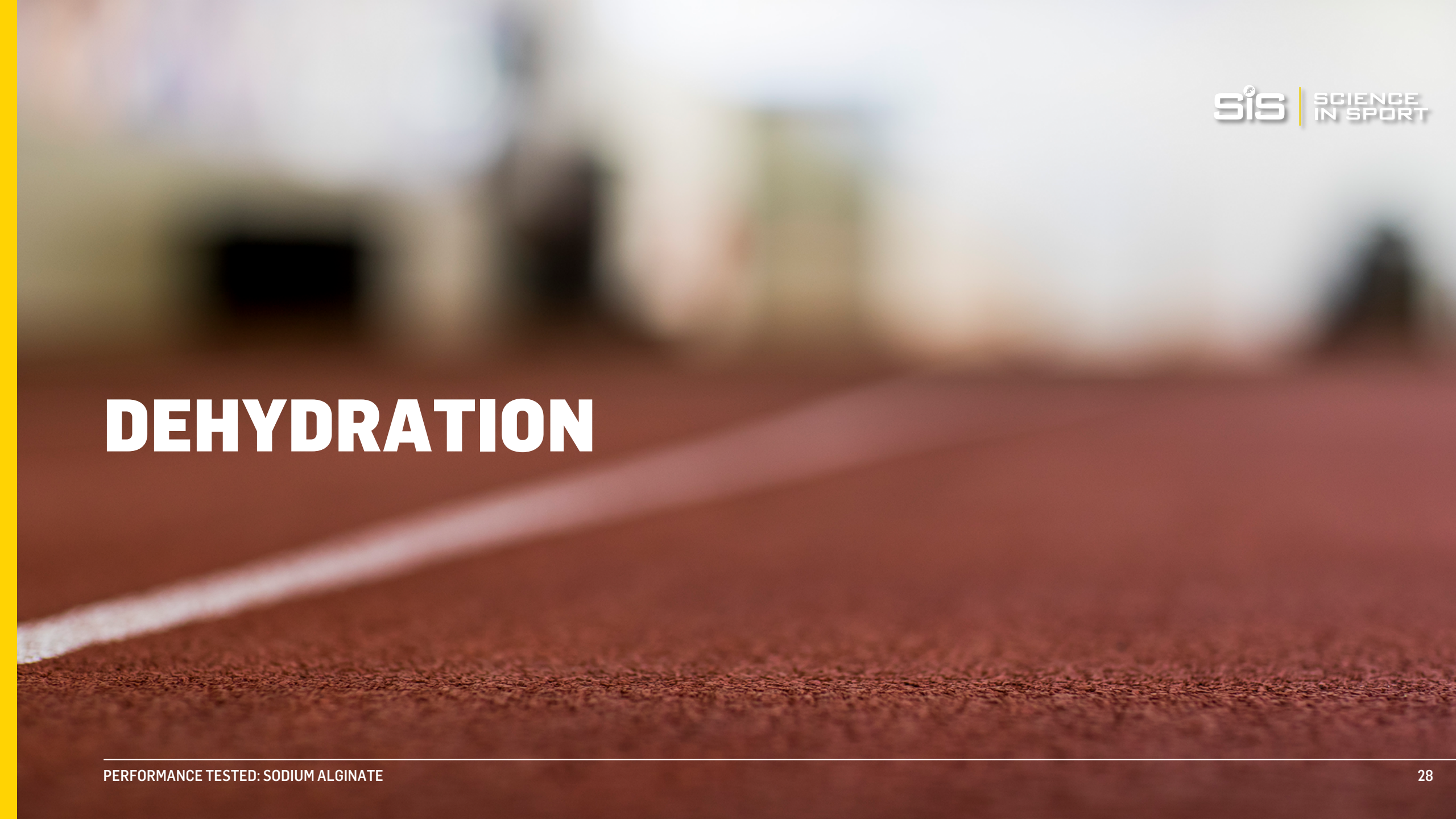


* denotes significant difference from Maurten and Placebo, P < 0.05.

STATISTICAL ANALYSIS

At the point of time trial completion, blood lactate concentration was not significantly (P = 0.61) different between trials.

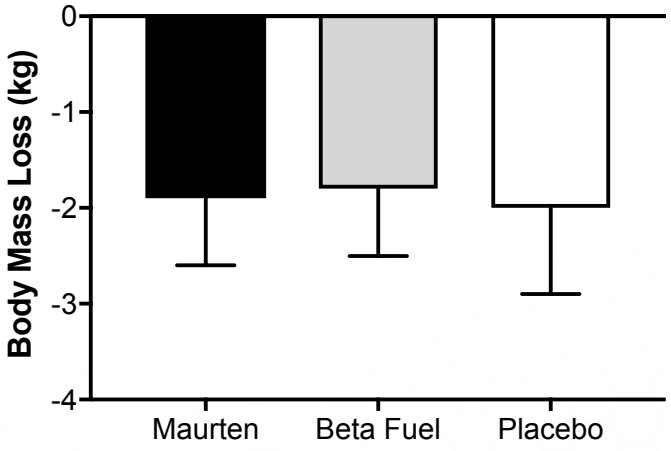


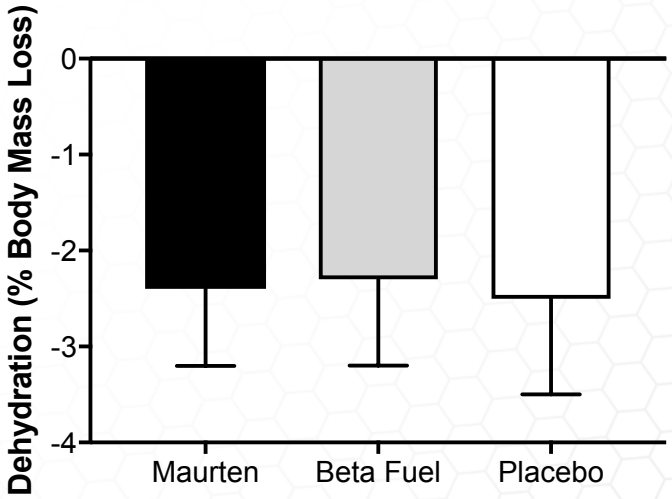


DEHYDRATION

STATISTICAL ANALYSIS

There was no significant difference in body mass loss between trials when expressed in absolute terms (kg) or % of body mass loss (P = 0.11 and 0.09, respectively).





CONCLUSIONS

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1. When total CHO intake is equivalent to approximately 80 g per hour, the inclusion of sodium alginate in a dual source CHO sports drink (Maurten Drink Mix 320) offers no superior performance benefits when compared to that of a dual source CHO isotonic sports drink alone (SiS Beta Fuel).

2. When total CHO intake is equivalent to approximately 80 g per hour, the inclusion of sodium alginate in a dual source CHO sports drink (Maurten Drink Mix 320) does not enhance blood glucose availability or total CHO oxidation when compared to that of a dual source isotonic CHO sports drink alone (SiS Beta Fuel). However, at the point of completion of the time trial, blood glucose concentration was significantly higher in the Beta Fuel versus Maurten trial suggesting that sodium alginate may compromise CHO digestion and absorption during high-intensity exercise conditions.
3. When total CHO intake is equivalent to approximately 80 g per hour, the inclusion of sodium alginate in a dual source CHO sports drink (Maurten Drink Mix 320) does not reduce incidence of severe or non-severe gastrointestinal symptoms when compared to that of a dual source CHO isotonic sports drink alone (SiS Beta Fuel).

4. Future studies should now examine both whole body and exogenous rates of CHO oxidation and the potential performance benefits of sodium alginate under conditions that are more challenging to the gut (i.e. when CHO intake is > 90-100 g per hour) and where CHO availability become more limiting to performance (i.e. exercise duration is > 3 hours).

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