INFLUENCE OF MODIFIED STARCHES ON MENTAL PERFORMANCE AND PHYSICAL ENDURANCE FOLLOWING EXHAUSTIVE EXERCISE

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Abstract

Slow-releasing carbohydrates may delay the effects of fatigue after exhaustive exercise. **Purpose:** Observe the influence that hydrothermally modified starches (HMS) and traditional maltodextrin (MAL) supplements had on physical endurance and mental performance following exhaustive exercise. **Methods:** Male participants completed a VO2 max and two days of cycling sessions using a Velotron ergometer. Cycling sessions were performed at 70% of the VO2 max workload for 150 minutes. Supplements were consumed 30 minutes prior to cycling and during exercise at the 120-minute mark (1 g CHO/kg body weight). Brain activity was measured using a Neuroscan 64-channel Electroencephalogram (EEG) cap. Go-no-Go and N-back tasks were performed before and after cycling bouts. Blood glucose, lactate, ketones, cortisone, and urine specific gravity were measured before, during, and after cycling. Heart rate (HR), VO2, and Rate of Perceived Exertion (RPE) were recorded in 15-minute intervals. **Results:** Ketones increased significantly more for HMS than MAL from pre to post cycling measurements ($p < .05$). Glucose spikes occurred for MAL. HR increased over time during MAL use. Reaction times for Go-no-Go and N-back were faster for HMS post exercise. Event Related Potential (ERP) differences were present in both mental tasks following exhaustive exercise. **Conclusion:** HMS supplementation decreased the impact of cognitive and physical fatigue post exercise.

Introduction

- Thydrothermally modified starches (HMS) and traditional maltodextrin (MAL) supplements have on physical endurance and mental performance.
- MAL supplements exhibit a high glycemic index which results in blood glucose spikes during exercise.[1]
- Large blood glucose spikes lead to temporary surges in energy, nevertheless, peak and leave athletes with a higher risk of premature fatigue.
- In contrast to rapid acting carbohydrates, a new supplement has been developed to reduce blood sugar spikes and provide a more stable release of glucose.
- HMS supplements have a lower glycemic index, providing a more stable release of glucose into the blood during exercise.
- With a lower glycemic index and slower digestion rate, HMS has demonstrated the potential he primary aim of this study is to observe the influences that to reduce the incidence of hypoglycemia over extended periods of time.[1]
- Larger gaps in research surrounding how physical fatigue impacts mental performance.
- Metabolic variables and cognitive tasks will be assessed before and after exercise bouts to measure the impact that each supplement has on mental performance.
- If the proposed biological markers remain stable throughout exercise, improved mental performance is to be expected because of the body maintaining a more homeostatic state.

Methods

Participants:
10 male cyclists were recruited to participate and 6 have completed the VO2 max test and both cycling sessions.

Demographics	Average ± SD	Range
Age (yrs)	30.86 ± 10.01	19-47
Height (m)	1.78 ± 0.08	1.68-1.9
Weight (kg)	78.57 ± 9.60	65.5-92.7
BMI (kg/m²)	23.38 ± 2.61	20.8-27.5
Body Fat %	10.02 ± 3.12	6.6-13
VO2 max (mL/kg/min)	47.97 ± 8.66	35.8-61.7

Methods

Procedure:
On the first visit, participants complete a VO2 max test on the cycle ergometer. The second and third visits involve consumption of either a MAL or HMS supplement before and during exercise. Prior to their second and third visit, participants are required to fast for at least ten hours. One gram of carbohydrate in the supplement is consumed per kilogram of the participant's body weight. Thirty minutes prior to cycling, participants consumed 1000-ml of water with the appropriate amount of supplement and another 700-ml following 120 minutes of cycling. The amount of water participants drink between the start of exercise and the 120-minute mark is measured, and the same amount must be consumed at the next visit. The exercise is performed on a cycle ergometer for 150 minutes at 70% VO2 max. VO2 is measured using the metabolic cart. Rate of Perceived Exertion (RPE) is measured using a standard 6-20 scale. Mental tests are performed before and after cycling. The mental tests include a Go-No-Go task and an N-Back task. EEG data is collected using a Neuroscan-64 channel EEG cap. A Biopac heart rate monitor is attached to the participant to collect heart rate variability.

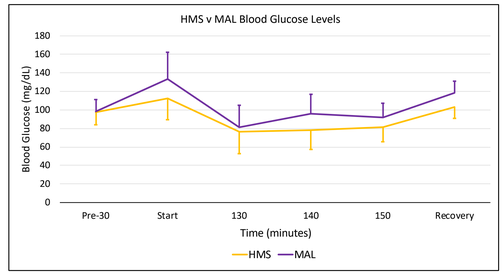
Biological Marker	Measure	Collection Method	Normative Ranges
Urine Specific Gravity	ATAGO Refractometer	Urine sample	1.000-1.030
Blood Lactate	Lactate Plus Meter	Finger prick	0.5-2.2 mmol/L
Ketones	Precision Xtra Blood Glucose Meter	Finger prick	<0.1 mmol/L
Blood Glucose	Precision Xtra Blood Glucose Meter	Finger prick	70-100 mg/dL
Cortisol	Universal Container	Saliva sample	10-15 ug/dL

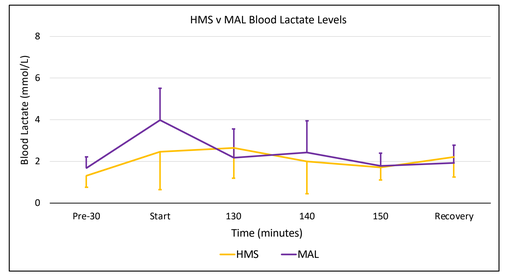
Results

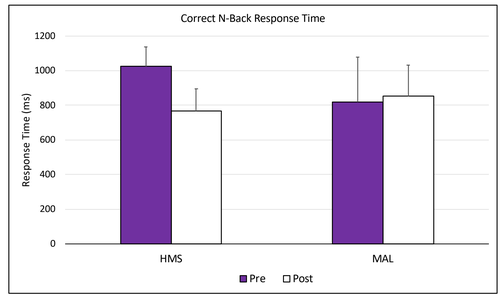
To test the effects of glucose, lactate, and ketones, three 2 (Supplement Type) x 6 (Time) repeated measures ANOVA were conducted. For glucose, the analysis indicated a significant main effect for Time, (5, 50) = 9.059, $p < .01$, $\eta_p^2 = .475$. Similarly, lactate demonstrated a significant main effect for Time, (5,55) = 3.124, $p < .05$, $\eta_p^2 = .221$. Neither glucose nor lactate demonstrated a significant main effect for Supplement Type or a Supplement Type x Time interaction. For ketones, the analysis indicated a main effect for Supplement type, (5,55) = 7.933, $p < .05$, $\eta_p^2 = .419$ and a significant main effect for Time, (5,55) = 20.104, $p < .01$, $\eta_p^2 = .646$, and a significant Supplement Type x Time interaction, (5,55) = 3.522, $p < .01$, $\eta_p^2 = .243$.

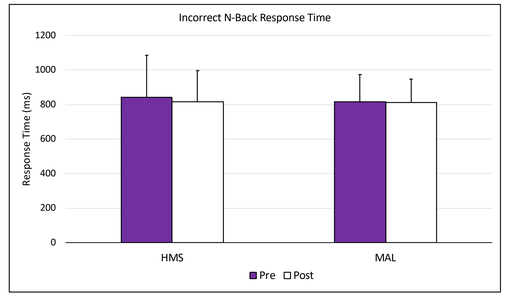
	Time (mins)	HMS	MAL	F	Sig	η_p^2
Glucose	Pre-30	97.17	98.71	9.059	p < .01	.475
	Start	112.5	133.43			
	130	76.50	81.29			
	140	78.20	96.14			
	150	81.50	91.71			
	Recovery	103.0	118.86			
Lactate	Pre-30	1.32	1.69	3.124	p < .05	.221
	Start	2.45	3.99			
	130	2.65	2.19			
	140	2.00	2.41			
	150	1.70	1.79			
	Recovery	2.22	1.91			
Ketone	Pre-30	0.17	0.10	20.104	p < .01	.646
	Start	0.12	0.13			
	130	0.28	0.17			
	140	0.32	0.20			
	150	0.32	0.18			
	Recovery	0.58	0.30			

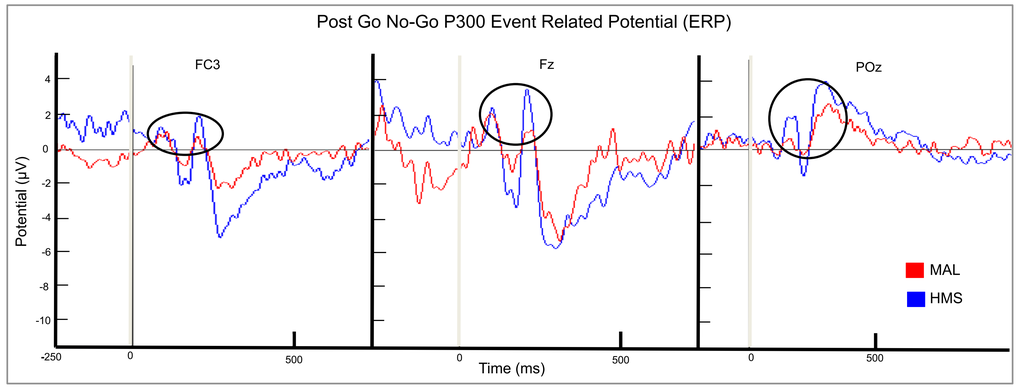
Results (continued)











Summary

- During exhaustive exercise, MAL produced greater spikes in blood glucose in comparison to HMS supplementation.
- Blood lactate levels increased in response to carbohydrates with a high glycemic index. This was expected, based on previous research.[2]
- Mental performance appears to improve after exercise and HMS consumption.
- P300 was reduced with MAL compared to HMS indicating greater fatigue with MAL consumption.
- Significant increases of ketone bodies in the blood throughout exercise suggests that HMS supplementation enhances lipolysis in comparison to MAL supplementation.

Selected References

1. Roberts, M.D., Lockwood, C., Dalbo, V.J., Volek, J., Kerksick, C.M. (2011). Ingestion of a high-molecular-weight hydrothermally modified waxy maize starch alters metabolic responses to prolonged exercise in trained cyclists. *Nutrition.* 27(6): 659-656. doi: 10.1016/j.nut.2D10.07.008.

2. Sun, F., Wong, S., Chen, S., Poon, T. (2015). Carbohydrate electrolyte solutions enhance endurance capacity in active females. *Nutrients.* 7(5) 3739-3750. doi: 10.3390/nu/7053739