

Nutritional strategies for maximizing recovery from strenuous exercise in the heat: An important role for carbohydrate (sago) supplementation

Comment on: Che Jusoh MR, Stannard SR, Mündel T. Sago supplementation for recovery from cycling in a warm-humid environment and its influence on subsequent cycling physiology and performance. *Temperature* 2016; 3:444–54; <http://dx.doi.org/10.1080/23328940.2016.1179382>

From a broader context, this above-mentioned paper¹ focuses on strategies to maximize post-exercise recovery in hot and humid environmental conditions; a topic that has received growing attention in the sports science literature. It is well known that aerobic performance is greatly impaired and psychophysiological responses are exacerbated during fixed-intensity exercise in the heat, including augmented increases in core body temperature, heart rate, glycogen utilization and rating of perceived exertion as compared to temperate conditions. More relevant to sports performance, self-paced exercise often results in earlier reduction of exercise intensity in the heat. This reduction minimizes the exacerbation of psycho-physiological loads, though often the ratio of the physiological response or perceived exertion to the work performed is greater than in temperate conditions. Given such exaggerated responses during exercise, it is intuitive to think that recovery is then slower after strenuous exercise in the heat. As evidence, higher core temperature, heart rate and lower voluntary neuromuscular force production were present 60 min after performing a high-intensity, intermittent-sprint cycling protocol at 33°C relative to 22°C.²

This slowing of the recovery kinetics due to the environmental conditions is of concern to athletes and sports science practitioners, as optimal recovery and readiness for subsequent performance is a key determinant for success in many sports. From a local perspective, to win a medal in the rapidly approaching 2016 Olympic Games in Rio de Janeiro, volleyball and basketball teams will play 8 matches with a 48-h interval between matches. According to the weather forecast, dry and wet temperatures in Rio are not expected to be very high during the Olympics, since August mean dry temperatures and relative humidity in Rio were ~23.2°C (21.6 – 24.8°C range) and 71% (67 – 75% range), respectively, during the last 14 years.³ However, some soccer games will be played outdoors in warmer cities, such as Manaus and Salvador. Soccer teams will also face a congested schedule, with those teams disputing medals playing 6 matches in 17 days. Consequently, all coaching staff should be aware that environmental heat stress may delay athletes' recovery between matches.

Although recovery is often addressed from a daily basis, shorter time frames may be important when sports require multiple daily bouts. In the latter context, Olympic schedules may be even more demanding for recovery of those athletes competing several times in a same day. For instance, judoists must win up to 7 fights on the same day to win an Olympic medal. Therefore, understanding recovery is also very important for planning and prescribing recovery procedures during competition.

With the above contextual demands in mind, recovery is essentially dependent on training/competition loads encountered, ensuing nutrition, and sleep patterns obtained (Fig. 1A). In the highlighted paper, the authors investigated a nutritional strategy that would maximize recovery in hot and humid (30°C, 77% RH) environmental conditions. They showed that a novel post-exercise sago supplementation (0.8 g/kg bodyweight) at the beginning of a 2-h recovery between exercise bouts in the heat maintained performance, whereas the control trial (with only water ingested) resulted in decreased performance (Fig. 1B).¹ Thus, the sago consumption showed

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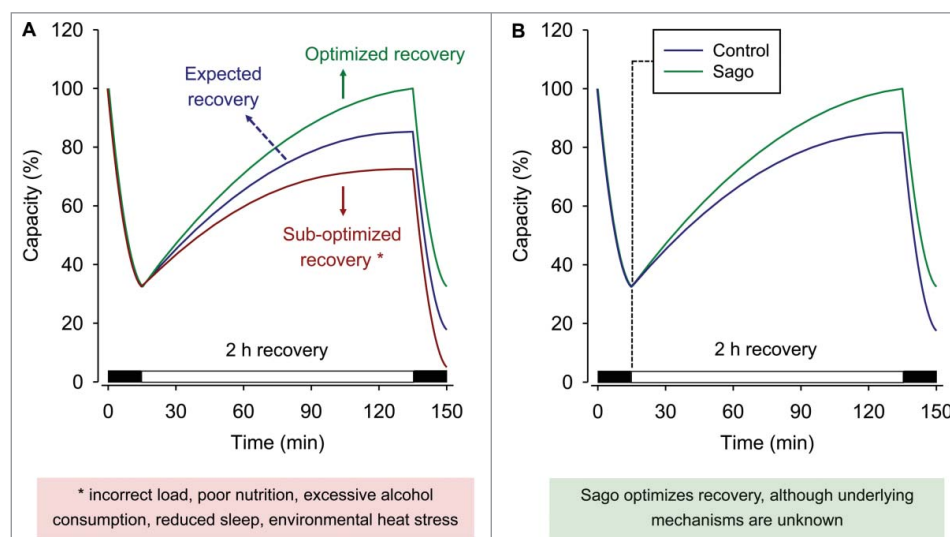


Figure 1. Theoretical schematic showing the expected (dashed blue line), optimized (green line) and sub-optimized (red line) 2-h recovery after a 15-min time trial in hot and humid conditions (panel A). Notably, the 2-h recovery was not sufficient to allow athletes to maintain their performance in the second exercise bout relative to the first bout; that is the reason why theoretical representation of expected recovery did not bring the control athletes' capacity to a 100% level before the initiation of the second bout. Sago supplementation optimized recovery and allowed athletes to maintain their performance in the second exercise bout (panel B). The black bars on bottom indicate the 2 exercise bouts, whereas the white bar indicates the 2-h recovery between exercise bouts.

similar beneficial effects as more commonly used carbohydrate (CHO) sources in the research literature. Of note, sago (*Metroxylum sagu*) is an important starch-based dietary CHO source in many parts of Southeast Asia. As a nutritional intervention, it is suggested to be easily digestible and quickly absorbed, and thus has potential to be prescribed as a CHO supplement during the peri-exercise period.

Mechanisms of fatigue in the control group are speculative, though important to understand how sago may have been ergogenic. Given the 15-min exercise bout separated by 2-h recovery, glycogen depletion / resynthesis are possible issues. This hypothesis is supported by the observation that, while sago increased blood glucose, most other parameters, including thermoregulatory and cardiorespiratory measures, were comparable between conditions at the start of the second bout.¹ In addition, higher lactate concentrations at the end of the second bout were reported after sago ingestion relative to the control trial, suggesting higher glycogen utilization. However, the role of sago (CHO) on enhancing recovery may be multi-factorial, and not solely related to faster glycogen resynthesis. Indeed, the presence of CHO on the tongue provides sensory information to the brain which may improve aerobic performance.⁴

Further research should also consider important issues related to blinding athletes (participants) to the treatment they are being subjected. For example, previous research demonstrates placebo effects may be associated with the performance enhancing effects of CHO supplementation. As evidence, Nassif et al.⁵ reported that the ingestion of CHO capsules in a double blind fashion did not change exercise time to fatigue of athletes cycling in a hot, humid environment. Moreover, relative to the placebo trial, exercise duration was significantly increased (~24%) when the ingestion of CHO was combined with the knowledge of ingesting the CHO.⁵ The fact that participants knew about the CHO intake may act as a powerful perceptual tool to improve performance.

In general, Che Jusoh and colleagues¹ demonstrated that sago has potential to be prescribed as a CHO supplement during recovery from exercise in the heat, although the mechanisms underlying the sago-mediated recovery optimizing effects are not clear. Moreover, given acute recovery is as much about perception as it is physiological, athletes should be aware that knowledge about the use of a performance enhancement supplement may provide beneficial psychological effects,⁵ particularly in environments that exacerbate perceived fatigue and degrade performance capacity.

References

- [1] Che Jusoh MR, Stannard SR, Mündel T. Sago supplementation for recovery from cycling in a warm-humid environment and its influence on subsequent cycling physiology and performance. *Temperature* 2016; 3:444-54; <http://dx.doi.org/10.1080/23328940.2016.1179382>
- [2] Duffield R, King M, Skein M. Recovery of voluntary and evoked muscle performance following intermittent-sprint exercise in the heat. *Int J Sports Physiol Perform* 2009; 4:254-68; PMID:19567928
- [3] INMET - Instituto Nacional de Meteorologia. <http://www.inmet.gov.br/portal/index.php?R=bdmep/bdmep>
- [4] Gant N, Stinear CM, Byblow WD. Carbohydrate in the mouth immediately facilitates motor output. *Brain Res* 2010; 1350:151-8; PMID:20388497; <http://dx.doi.org/10.1016/j.brainres.2010.04.004>
- [5] Nassif C, Ferreira AP, Gomes AR, Silva Lde M, Garcia ES, Marino FE. Double blind carbohydrate ingestion does not improve exercise duration in warm humid conditions. *J Sci Med Sport* 2008; 11:72-9; PMID:18023253; <http://dx.doi.org/10.1016/j.jsams.2007.08.015>

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