Science versus practice:
The past, present and future of carbohydrates in food and drinks for sport and exercise

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Senior Sport Scientist
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We have a long and proud history

- 1899 Suntory
- 1927
- 1938
- 1947
- 1955
- 1989
- 2001
- 2014
Research and development at LRS

The Applied Research and Claims team deliver a pipeline of technologies by generating new to world data; assimilate pre-existing data to create new or optimised product and claims opportunities; and search for technologies through Open Innovation.
Consumer centricity is at the heart of innovation
Understanding need states of individuals

<table>
<thead>
<tr>
<th>Mind</th>
<th>Energy</th>
<th>Mental focus</th>
<th>Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health</td>
<td>Cardiovascular</td>
<td>Body weight / composition</td>
<td></td>
</tr>
<tr>
<td>Body</td>
<td>Shaping up</td>
<td>Physical performance</td>
<td>Energy and fuel</td>
</tr>
</tbody>
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The value of scientific insight

Science  →  Practice  →  Solution

Need states  ↓  Requirement  ↓  Recommendation

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Advancements in Carbohydrate and Sport Performance research

1920
Krogh and Lindhard
CHO and Fat metabolism at rest and during exercise

1925
Gordon et al.
Sugar sweets during Boston marathon

1974
Gollnick et al.
Exercise intensity and CHO use

1995
Nicholas et al.
CHO-E drink and intermittent exercise protocol

2000
Jeukendrup and Jentjens
CHO oxidation rate during exercise

2004
Jentjens et al.
Glu: Fru drinks and CHO utilisation during exercise

2008
Currell and Jeukendrup
Glu: Fru drinks and performance

2009
Stevenson et al.
CHO-E+caffeine drink and golf performance

2009
Rollo et al.
Mouth rinsing with CHO-E and running performance

2015
Newell et al.
Dose response in CHO ingestion on performance
What do we mean by carbohydrate availability?

The content of carbohydrate that is found in the human body available to be used for energy production

Energy stores in a 70-kg person:
CHO: 1,756 Kcal
FAT: 110,000 Kcal
Carbohydrate feeding increases carbohydrate availability in the body which is important for exercise performance

Feeding 30-60 g of carbohydrate during exercise lasting longer than 60 minutes significantly improves exercise performance

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Newell et al Int J Sport Nutr Exerc Metab. 2014

* Indicates a significant increase from water (p<0.05)
Factors that increase glycogen use during exercise

- Exercise intensity
- Exercise duration
- Training status
- Low carbohydrate diet
- Dehydration (> 3 % BM)
- Very high carbohydrate diets (> 70% EI)

Therefore understanding individual carbohydrate availability would prove beneficial for *product innovation and recommendations*
Carbohydrate feeding during and after exercise increases carbohydrate availability which is important for exercise performance.

One size does not fit all:

- Exercise intensity
- Exercise duration
- Training v Competition
- Sporting goal
- Gut adaptations

These recommendations are from lab based exercise tests.

- How do they relate to real life sport and exercise?
- How can we link our current understanding to consumer / athlete need states?
But increasing the reliance of fat is important…

So let’s just eat fat, right?

Published Data—Short to Moderate Term Fat Adaptation or Ketogenic Dietary Impact on Exercise Performance (each individual perf. test per study shown)

**Performance Decrease (12)**


**No Effect (7)**


**Improved Performance (2)**


Source: Stellingwerff Online

https://twitter.com/tstellingwerff/status/533690289987145729


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“So I have put the players on a low carbohydrate diet to improve how they adapt to training, which is a good thing. But they will probably run slower and generally be more sluggish during training. Hope you are ok with that!”
Use It or Lose It
Carbohydrate smart – periodisation the type and amount of carbohydrate relevant to physical demand

<table>
<thead>
<tr>
<th>Training intensity</th>
<th>Carbohydrate intake target</th>
<th>Average 70 kg individual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>Low intensity and skill based exercise daily</td>
<td>3-5 g/kg/day</td>
</tr>
<tr>
<td>Moderate</td>
<td>Moderate exercise programme (&lt; 1 h / day)</td>
<td>5-7 g/kg/day</td>
</tr>
<tr>
<td>High</td>
<td>Endurance programme (1-3 h / day &gt;60% VO₂ max)</td>
<td>6-10 g/kg/day</td>
</tr>
<tr>
<td>Very high</td>
<td>Extreme commitment (&gt; 4-5 h / d &gt;60% VO₂ max)</td>
<td>8-12 g/kg/day</td>
</tr>
</tbody>
</table>

It is possible to use a sliding scale for carbohydrate intake depending on sporting goal and demand
What sports rely on carbohydrate availability for optimal performance?

- NO?
- YES
- YES
- YES
- SOMETIMES
- SOMETIMES
- YES

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Has the world of sport / exercise changed?
How do we get scientific insight into consumers exercise today?

Do the current recommendations fit real life exercise and sport?

How does this impact the recommendations we provide for nutrition innovation?
Where does this leave us for carbohydrate recommendations for exercise and sport in the real world?
XXX. THE RELATIVE VALUE OF FAT AND CARBOHYDRATE AS SOURCES OF MUSCULAR ENERGY.

WITH APPENDICES ON THE CORRELATION BETWEEN STANDARD METABOLISM AND THE RESPIRATORY QUOTIENT DURING REST AND WORK.

By AUGUST KROGH and JOHANNES LINDHARD,

with the collaboration of
GÖRAN LILJESTRAND and KNUD GAD ANDRESEN.

From the Laboratory of Zoophysiology, Copenhagen University.

(Received August 26th, 1919.)
What technologies are available to assess carbohydrate availability?
What technologies are available to assess carbohydrate availability?

The modern day laboratory
What technologies are available to assess carbohydrate availability?

Accessibility of techniques

Gold standard / Informative techniques

Limitation to our understanding of carbohydrate availability today is the gap between the lab and the field
What is the carbohydrate cost of routine training sessions in recreational runners?
How could we assess magnitude of change in carbohydrate availability with new technologies?

Emerging technology using ultrasound is a potential way of measuring carbohydrate availability that is convenient tool to measure real life changes at the point of sweat.
What will the future hold for linking up technologies?

Data validation is essential to make sure evidence based practice can be ensured.
What have I told you today?

Science → Practice → Solution

Need states → Requirement → Recommendation