Institution: Nottingham Trent University

Unit of Assessment: C26 Sport and Exercise Sciences, Leisure and Tourism

Title of case study:
Informing the use of beta-alanine supplementation for performance enhancement.

1. Summary of the impact

Research from the Unit has demonstrated a positive effect of the amino acid beta-alanine on exercise performance and capacity, which has informed best practice on its use by elite athletes, athletic individuals and the general population. In addition, this research has allowed performance nutritionists and exercise physiologists access to research that affords them the ability to follow an evidence based practice approach with their clients. Our research has contributed to the increased worldwide use of beta-alanine as a dietary supplement to enhance sport and exercise performance.

2. Underpinning research

Major breakthroughs from our Sport, Health and Performance Enhancement Research Group include the confirmation of the effect of beta-alanine supplementation on high-intensity cycling capacity and the fact that this can be enhanced further by co-supplementation with sodium bicarbonate (Ref 1). This has created a new research stream relating to the co-supplementation of these buffering agents, with numerous papers from our research group and others relating specifically to this. Furthermore, we have shown significant effects of beta-alanine supplementation on basic exercise tests, including isometric exercise capacity of the knee extensors (Sale et al., 2012, *JISSN*, 9, 26. DOI: 10.1186/1550-2783-9-26) and, following confirmation of beta-alanine's effects on different exercise models, we have extended the scope of our studies to show effects on sport specific tests. These include soccer specific exercise capacity (Ref 2), 2000m rowing (Ref 3) and collaboratively on swimming performance (Painelli et al., 2013, *APNM*, 38, 525-532. DOI: 10.1139/apnm-2012-0286) and upper body exercise in judo and jiu-jitsu competitors (Tobias et al. 2013, *Amino Acids*, 45, 309-317. DOI: 10.1007/s00726-013-1495-z). Of particular relevance to the athlete, we have also shown, in a collaborative study, similar effects of beta-alanine in trained versus untrained participants. Just as importantly, we have published data to show where beta-alanine has not been successful in improving sport performance (Ref 4).

In addition to our original research, we have been instrumental in providing information on the efficacy of beta-alanine supplementation for exercise performance through the production of one of the first review papers on the topic (Ref 5) and the only meta-analysis to date (Ref 6). Further reviews (Harris et al., 2012, *Amino Acids*, 43, 39-47. DOI: 10.1007/s00726-012-1233-y; Sale et al., 2013, *Amino Acids*, 44, 1477-1491. DOI: 10.1007/s00726-013-1476-2) and two invited book chapters have added to the evidence base in this regard. These summary outputs, alongside industry specific publications (*e.g.*, Sale and Saunders, 2012, *Professional Strength and Conditioning*, 27, 26-31), are critical in engaging with applied practitioners and have helped SHAPE to be at the forefront of applied research in this area.

Evidence of our contribution to the international debate on the importance of beta-alanine supplementation, is provided by Dr Sale's inclusion on the Scientific Committee of the International Congress on Carnosine in Exercise and Disease at the University of Ghent in Belgium (Derave and Sale, 2012, Amino Acids, 43, 1-4. DOI: 10.1007/s00726-012-1281-3), where he presented a keynote lecture on the ergogenic potential of beta-alanine. Dr Sale remains on the International Scientific Committee for the 2014 Congress planned to be held in Tokyo, Japan. Significant international collaborations have been developed, most notably with the University of Sao Paulo (Brazil) and the University of Ghent (Belgium).

To summarise, research from SHAPE has led to the identification of the range of influences of beta-alanine supplementation on exercise performance and capacity. It should also be noted that our research has been the catalyst for the research of other groups worldwide on beta-alanine alone and in combination with other supplements (*e.g.*, sodium bicarbonate). As evidence of the level of our research and the regard with which it is held in by the International community, the CEO of the International Society of Sports Nutrition states "…*I would like to offer my support and recognition of the excellent scientific work performed at Nottingham Trent University…Beta-alanine*

has been shown to be of incredible importance in the athletic arena and has clearly shown to enhance both the sports world and the world of academic research…….With 15 full papers published in the most distinguished of scientific journals, the Nottingham group has made significant strides in the understanding of sports performance vis a vis beta-alanine…The research group at Nottingham is perhaps the most distinguished in the world in the field of beta-alanine research."

3. References to the research (indicative maximum of six references)

1. Sale, C., Saunders, B., Hudson, S., Wise, J.A., Harris, R.C. and Sunderland, C.D. (2011). Effect of β-alanine plus sodium bicarbonate on high-intensity cycling capacity. *Medicine and Science in Sports and Exercise*, 43(10), 1972-1978. DOI: 10.1249/MSS.0b013e3182188501. Impact factor: 4.475, Scopus citations: 21.

2. Saunders, B., Sunderland, C.D., Harris, R.C. and Sale, C. (2012). β-alanine supplementation improves YoYo Intermittent Recovery Test Performance. *Journal of the International Society of Sports Nutrition*, 9, 39. DOI: 10.1186/1550-2783-9-39. Impact factor: 1.825, Scopus citations: 3.

3. Hobson, R.M., Harris, R.C., Martin, D., Smith, P., Macklin, B., Gualano, B. and Sale, C. (2013). Effect of Beta-Alanine With and Without Sodium Bicarbonate on 2,000-m Rowing Performance. International Journal of Sports Nutrition and Exercise Metabolism, 23, 480-487. Impact factor: 1.861, Scopus citations: 0.

4. Saunders, B., Sale, C., Harris, R.C. and Sunderland, C. (2012). Effect of beta-alanine supplementation on repeated sprint performance during the Loughborough Intermittent Shuttle Test. *Amino Acids*, 43(1), 39-47. DOI 10.1007/s00726-012-1268-0. Impact factor: 3.914, Scopus citations: 8.

5. Sale, C., Saunders, B. and Harris, R.C. (2010). Effect of beta-alanine supplementation on muscle carnosine concentrations and exercise performance. *Amino Acids*, 39(2), 321-333. DOI: 10.1007/s00726-009-0443-4. Impact factor: 3.914, Scopus citations: 37.

6. Hobson, R.M., Saunders, B., Ball, G., Harris, R.C. and Sale, C. (2012). Effects of β-alanine supplementation on exercise performance: a meta-analysis. *Amino Acids*, 43(1), 25-37. DOI: 10.1007/s00726-011-1200-z. Impact factor: 3.914, Scopus citations: 18.

These references have been selected from our body of peer-reviewed work on this topic. As testament to the level of this work, it has led to Dr Sale being invited to: sit on the Scientific Committee of the International Congress on Carnosine in Exercise and Disease; give invited talks at the same Congress, on the International Olympic Committee Diploma, the International Society of Sports Nutrition Diploma course, and at various institutions Nationally and Internationally; invited review papers and book chapters and to review grants for awarding bodies in Belgium and Poland.

4. Details of the impact

Research from the Unit has helped to "…create, within the space of just a few years, an entirely new product in sports nutrition, one supported by objective evidence and material that can be used for educational purposes" as confirmed by the Operations Manager for QNT UK Ltd (letter sent 2nd November 2012).

The Units research provides evidence that the impact of beta-alanine to sporting/exercise performance ranges between 2 and 30%, depending upon the individual, the event and the situation. Consequently, beta-alanine supplementation is now internationally recognised as a significant new player in relation to the athlete's nutritional toolkit. According to the Physiology Lead, Canadian Sport Centre-Pacific it provides a healthy and legal enhancement of athletic performance. As such, further impact has been enabled through influencing the awareness, practice and performance of elite athletes worldwide, through the engagement of elite athletes and key practitioners within our research. For example, the Physiology Lead, Canadian Sport Centre-Pacific (Source 2) goes on to state (in a letter supplied 1st March 2013) that SHAPEs research has, "…*substantially progressed our understanding of the efficacy behind beta-alanine…..of the nearly 300 athletes at the 2012 London [Olympics], I would estimate that about 100 athletes have used*

beta-alanine at some point in the preparations". Similar evidence is provided by the former Head of Performance Nutrition at the English Institute of Sport (Source 3) who states (letter supplied 18th June 2013) that "*The research produced and published by this group of researchers was incorporated into the training programme and strategies used by GB athletes in the lead up to and during the most recent 2010 Commonwealth and 2012 Olympic and Paralympic Games….."*

The specific use of SHAPE research on beta-alanine to support UK based athletes was explained by the current Head of Performance Nutrition at the English Institute of Sport (Source 4), letter supplied to SHAPE, 27th June 2013) who confirmed that the outcomes of the research from Ref 2 have been used to support the use of beta-alanine in Rugby, Hockey and with the England Cricket Team. Similarly, the outcomes from Ref 6 have been used to support the use of beta-alanine across a range of sports including GB short track speed skating, canoe slalom and GB swimming and Ref 1 has supported the use of beta-alanine in combination with sodium bicarbonate with GB short track speed skating and synchronised swimming.

In addition to the use by Canadian and GB athletes, there is also evidence of impact delivered in Australia and New Zealand. Evidence for this is supplied by the Head of Sports Nutrition at the Australian Institute of Sport (Source 5) who confirms (letter dated 2nd June 2013) that, "*We have benefitted from the publications and presentations that have been produced, as well as the generous insights we have gained via direct communication with Dr Sale…Based on Dr Sale's research, and work of our own, we have implemented protocols of use of β-alanine by AIS athletes. We are also aware of its use by many other sports programs that value evidence-based supplement uses."* Similarly, the Lead Performance Nutritionist, High Performance Sport New Zealand (Source 3) states (letter dated 18th June 2013) that our research has *"….led to the development of effective nutritional interventions to assist and support sports performance….beta alanine supplementation is presently being used to support athletes in New Zealand High Performance Sport system in training, and/or competition in sports such as Athletics, Cycling, Rowing, Triathlon, Hockey, Rugby, and selected winter sports at the elite level…."*

The Units research has also led to significant impact in Rugby where the Rugby Football Union of Wales (confirmed by a letter from the WRU National Squad Nutritionist dated 30th October 2012) and the England Woman's 7s team (confirmed by a letter from the Lead Performance Nutritionist with the English Institute of Sport, 2nd May 2013) have used it to develop beta-alanine strategies during key training phases. It has also informed the content of a pre-game formula used by some premiership football clubs (confirmed by the Director of Pro Athlete Supplementation Ltd in a letter dated 30th October 2012). To further develop impact, we disseminate findings directly to the athletes and practitioners ahead of the outputs of our research findings, which can often incur significant delay in publication time, as highlighted above. For example, this has helped nutritionists and athletes to develop their strategies, for the women's Rugby 7s World Cup in June 2013 and preparation for the 15s World cup in 2014 (confirmed by a letter from the Lead Performance Nutritionist with the English Institute of Sport, 2nd May 2013).

It is evident through our research and that of our collaborators (some informed by our work) that beta-alanine is a nutrient previously overlooked. The persistence of our research group has helped to establish it as a worldwide sports nutrition product. To confirm this, the United States imported around 350,000 kg of beta-alanine annually in 2008, which has dramatically increased to around 800,000 kg in 2010, 2012 and 2013 and the global production of beta-alanine for use as a dietary supplement has increased dramatically from 2008 (figures supplied by Natural Alternatives International, San Marcos, California, US; July 2013).

One of the additional ways our research has helped to develop the use of beta-alanine as a new dietary product is its use in marketing and promotional material by those commercial companies selling the products. As the Operations Manager for QNT UK Ltd states (letter dated 2nd November 2012) *"A good example of the synergy between academia and industry…..has been the research carried out by Nottingham Trent University on beta-alanine, and also the publication of leading review articles on this topic by this group."* Further support for our role in this comes from the Global Head of Performance Nutrition Research and Development at Nestle (Source 1) who

reports (letter dated 11th July 2013), *"Nestle currently markets beta-alanine products globally under two different sub-brands, PowerBar and Musashi…In fact, information from Craig's studies have been incorporated into some of our communication materials used with sports nutrition practitioners."* Similarly, the Director of Pro Athlete Supplementation Ltd confirms that (letter dated 30th October 2012) *"Pro Athlete Supplementation developed a pre-game formula that contains Beta Alanine and has been widely used by premiership football clubs and international rugby teams. Helping to market this is a study from Nottingham Trent University to be published by the International Journal of Sports Nutrition later this year, which demonstrates its effectiveness in a test designed to replicate football specific exercise capacity."*

To summarise, the research undertaken within the Unit in relation to beta-alanine supplementation has had very significant impact and reach and provides an excellent example of the potential for synergy between academia, industry and the end user. As the Head of Sports Nutrition at the Australian Institute of Sport *confirms "…the research on β-alanine supplementation performed by Dr Sale can be said to have far-reaching international significance and impact."*

5. Sources to corroborate the impact (indicative maximum of 10 references, only 5 from people)

1. Global Head, Performance Nutrition R & D, Nestle. Corroborates the use of our research in marketing material in one of the major commercial companies producing beta-alanine as a dietary supplement product.
2. Physiology Lead, Canadian Sport Centre-Pacific. Corroborates the development of beta-alanine as a novel and useful dietary supplement for the elite athlete and also the use of SHAPEs research in informing the use of beta-alanine by Canadian athletes, particularly in preparation for the latest London Olympics 2012.
3. Lead Performance Nutritionist, High Performance Sport New Zealand and former Head of Performance Nutrition, English Institute of Sport. Corroborates the use of our research by numerous sports in New Zealand at the elite level and also the previous use of our research to support the use of beta-alanine by GB athletes in preparation for Commonwealth and Olympic/Paralympic Games
4. Head of Performance Nutrition, English Institute of Sport. Corroborates how the specific papers cited in this case study have directly informed beta-alanine use by elite athletes under the care of the English Institute of Sport
5. Head of Sports Nutrition, Australian Institute of Sport. Corroborates the dissemination of information by publication, presentation and discussion and the fact that this is used directly to support an evidence based approach to beta-alanine supplementation in elite Australian athletes. Also corroborates that our research has had significant and far reaching impact.