Institution: University of Leeds

Unit of Assessment: UoA6

Title of case study:
Case Study 2: Research on the bioavailability of (poly)phenols supports global marketing of new Green Blend "functional" coffee

1. Summary of the impact (indicative maximum 100 words)

Research by Professor Gary **Williamson** and researchers at the University of Leeds (UoL) has revealed new pathways of polyphenol absorption and metabolism in humans, including the effect of gut microflora on the bioavailability of these natural compounds found in coffee, having major **impact on commerce**. Output has provided the scientific evidence to support Nestlé's post-launch marketing for its Green Blend coffee. The UoL research supports Green Blend's key positioning as a "functional" coffee with health benefits because it delivers high levels of antioxidants to the body. The brand has estimated global sales of hundreds of millions of pounds per year.

2. Underpinning research (indicative maximum 500 words)

Fresh (green) coffee beans contain high levels of chlorogenic acids, precursors of antioxidants that are known to reduce the risks of developing diabetes and cardiovascular disease. However, these acids degrade during high temperature roasting.

Identifying the potential value of a coffee product rich in chlorogenic acids, Nestlé, the world's largest food company, launched a research programme in 2004 led by Gary **Williamson** (then Head of Nutrient Bioavailability at the Nestlé Research Center). The programme was set up to support Nestlé's new pipeline product Green Blend, which contains a mix of green and roasted coffee.

The research aimed to investigate the bioavailability of antioxidant compounds in coffee and to study their metabolic pathways and functions in organisms. This research effort was extended when **Williamson** moved in January 2007 to UoL to take up the position of Chair of Functional Foods in the School of Food Science and Nutrition. UoA6 was awarded a grant of £600,000 by Nestlé for collaborative research on phenolic bioavailability, led by **Williamson**, who was employed part-time (20 %) by Nestlé until June 2012, at which point he become a full-time UoL employee. Much of the research described below was performed at UoL, as well as at the Nestlé Research Center, demonstrating the strong linkage between the two organisations and their two-way influence on the research programme and methodologies.

The first research period (2007-2011) revealed how several naturally occurring phenolic conjugates from coffee are taken up by the body after coffee ingestion and how these, after absorption and metabolism, may interact with key sites of the human organism when part of a normal diet. The studies were carried out to resemble physiological conditions and the average consumption of the drink as closely as possible (see details below).

Bioavailability of chlorogenic acids in coffee

Research by **Williamson** and co-workers in Leeds and F. Dionisi at Nestlé, used HPLC to analyze for the first time chemical and enzymatic synthesis of coffee-derived metabolites and revealed that metabolism of chlorogenic acids involves several hydrolysis and conjugation reactions which produce phenolic derivatives. The work in Leeds was the first to successfully measure these phenolic conjugates in biological fluids [1]. (The chemical syntheses in this work were carried out by D. Barron (Nestlé)).

Williamson continued to conduct work in Leeds to elucidate the pathways of metabolism for the phenolic conjugates, identifying the important contribution made by the gut microflora on absorption and hence bioavailability [2]. Complementary collaborative studies led by Professor Alan Crozier at the University of Glasgow looked at the bioavailability of chlorogenic acids from coffee in people who had had their small intestine removed. As indicated by the published papers,

in general Crozier focused on identification, **Williamson** on quantification. These studies revealed that the microflora increases absorption of coffee phenolics, helping to explain the variety of observed mechanisms by which the body handles different xenobiotic compounds (i.e., those not produced by humans) contained within foods [3].

Comparison of coffee and tea

Between 2007 and 2011, **Williamson** collated published data from the scientific literature and results from UoL experimental studies for a critical and quantitative evaluation of how much antioxidant chlorogenic acids and their metabolic derivatives were taken up by humans from a single dose (i.e., one cup of coffee or tea). Based on average uptake calculated from the data, **Williamson** was able to conclude that uptake of phenolics from coffee is 70% higher than from green tea on a molar basis, even though both of these drinks contain approximately the same quantity of total phenolics, published in 2011 [4]. **Williamson** carried out the bulk of the literature and data analysis, with contributions from Dionisi and Renouf at the Nestlé Research Center. **Williamson** was invited to publish his review in the peer-reviewed journal *Molecular Nutrition and Food Research*.

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

1. **Farrell**, T., Poquet, L., Dionisi, F., Barron, D., and **Williamson**, G. (2011). Characterization of hydroxycinnamic acid glucuronide and sulfate conjugates by HPLC-DAD-MS(2): Enhancing chromatographic quantification and application in Caco-2 cell metabolism. *J. Pharm. Biomed. Anal.*, **55**, 1245-1254. 10.1016/j.jpba.2011.03.023 [doi].
   SCOPUS citations: 7 [Accessed 5 June 2013]

2. **Farrell**, T.L., Gomez-Juaristi, M., Poquet, L., Redeuil, K., Nagy, K., Renouf, M., and **Williamson**, G. (2012) Absorption of dimethoxycinnamic acid derivatives in vitro and pharmacokinetic profile in human plasma following coffee consumption. *Mol. Nutr. Food Res.*, **56**, 1413-1423. 10.1002/mnfr.201200021 [doi]

3. Stalmach, A., Steiling, H., **Williamson**, G., and Crozier, A. (2010). Bioavailability of chlorogenic acids following acute ingestion of coffee by humans with an ileostomy. *Arch. Biochem. Biophys.* **501**, 90-105. 10.1016/j.abb.2010.03.005 [doi]

4. **Williamson**, G., Dionisi, F., and Renouf, M. (2011) Flavanols from green tea and phenolic acids from coffee: Critical quantitative evaluation of the pharmacokinetic data in humans after consumption of single doses of beverages. *Mol. Nutr. Food Res*., **55**, 864-873. 10.1002/mnfr.201000631 [doi]. [SCOPUS citations: 16 [Accessed 5 June 2013].
   *[Invited review, based on **Williamson** being one of the highest cited authors in the journal.*

Note: All researchers from UoL in **bold**. All of the above journals are internationally recognised with rigorous review processes and international editorial boards. All references cited are joint publications between the UoL and the Nestlé Research Center, demonstrating the inter-linked nature of the research outputs.

Funding

The references [1-4] are direct outputs from the following funding awarded to UoL from the Nestlé Research Center:

- European Centre for Polyphenol Research. Research grant awarded by Nestlé Research Center. PI **Williamson**. 2007-2011. £600,000
- European Centre for Polyphenol Research – 2. Research grant awarded by Nestlé Research Center. PI **Williamson**. 2012-2014. £800,000.

4. Details of the impact (indicative maximum 750 words)

Nestlé's research programme into the bioavailability and metabolism of coffee-derived phenolic compounds was established to back up the 'functional' claims of new and existing functional foods, specifically its Green Blend coffee. This has led to impact on the industry in terms of: **investment**

in research and development; **adoption of new technology and processes** to produce this new coffee; **commercialisation of the new product**.

Scientific support for marketing claims

The research to elucidate the bioavailability of phenolic conjugates from coffee has provided a strong scientific basis from which Nestlé has been able to submit marketing authorisations for its Green Blend 'functional' coffee brand, in many jurisdictions and countries worldwide. Although each country has its own rules about the evidence required to support functional claims, the UoL research has underpinned marketing applications, allowing Nestlé to sell Green Blend as a functional product or one high in antioxidants, and this was patented in 2010 [A].

In Australia, for example, the Green Blend label claims that the product "delivers 70% more antioxidants than green tea" [B]. This claim is backed up by **Williamson**'s review (Section 3, Ref 4) of the bioavailability of different antioxidants in coffee and tea.

Williamson also played a key role during the UK launch of Green Blend and he is quoted in the launch press release [C]. The launch emphasised the scientific evidence on the antioxidant benefits from the product. **Williamson** provided a scientific expert's perspective on the brand's health claims; he was also able to explain the issues of bioavailability and present key research findings on Green Blend (and its comparison with green tea and other foods) to journalists at the Green Blend launch event in London in 2009. He was quoted widely in articles about the product and he participated in radio interviews and discussions [D].

Further impact within Nestlé

A statement from Nestlé notes that "the contribution… has greatly underpinned and strengthened Nestlé's post-launch position of a successful new coffee product (Nescafé Green Blend) currently with global sales of hundreds of millions of pounds per year" [E]. Among the benefits to the company, Nestlé says the research has:

- re-enforced positive messages on coffee and health in the coffee market
- contributed to the claims for the antioxidant and polyphenol content of the products being sold being widely accepted
- helped Nestlé's marketing teams to use this to their advantage and "..had a very clear and positive impact on this business"
- allowed the company to run workshops and meetings on Green Blend with key opinion leaders to present and explain the positive effects on health.

In 2011 **Williamson**'s work was compiled along with output from other research groups into a confidential dossier that catalogued all the research carried out by the Nestlé Research Center, **Williamson**'s group in UoA6 at the UoL and other institutions into the absorption, metabolism and bioavailability of antioxidant compounds in coffee, specifically Green Blend [F]. This dossier provides Nestlé with a comprehensive evidence base for existing and potential claims about the health benefits of its Green Blend coffee, specifically the delivery of antioxidants to the body from the drink, as highlighted in the Australian market.

The high antioxidant levels and bioavailability claims derived from the UoA6 research are at the core of Green Blend's positioning in the market. Nestlé has even patent protected the marketing and sales processes which emphasise bioavailability [A]. The UoA6 research is central to the patent and **Williamson** is one of the named inventors. This patent demonstrates the extent to which the UoA6 research is driving Green Blend marketing, its competitive positioning and its differentiation in the market.

Sales growth

Nestlé will not publically release sales figures from individual products. However, Green Blend is currently sold in many countries worldwide and has global sales estimated at hundreds of millions of pounds per year. Analysis by a finance journalist for Reuters noted that Nestlé's 2009

performance [G] “was boosted by strong growth from its coffees like Dolce Gusto and Green Blend.” The successful performance of Green Blend was confirmed by the Head of Investor Relations at Nestlé S.A. in a first quarter sales conference call in 2010 [H].

5. Sources to corroborate the impact (indicative maximum of 10 references)

[A] Published patent: Inventors: Renouf, M., Guy, P. A., Marmet, C. C. O., Steiling, H., Cavin, C., **Williamson**, G. (2010). Method of promoting and selling coffee. WO2010/029076 PCT/EP2009/061637.

[B] Picture of Green Blend coffee label, Australia

[C] Websites from Nestlé linking the launch of the coffee to Prof **Williamson** at Leeds University:
http://www.nestle.co.uk/media/pressreleases/Pages/GiveUpGivingUp%E2%80%93ItMightDoYouGood.aspx

[D] Some web sites showing the link between the launch of Nestlé green blend coffee in the UK and the research of Prof Gary **Williamson** at Leeds University.
http://giventodistractingothers.blogspot.co.uk/2011/02/nescafe-green-blend-wow-coffee-is-good.html
http://www.sofeminine.co.uk/diet-healthy-recipes/green-coffee-tried-and-tasted-n40327.html
http://www.thehandbook.com/blog/nescaf%C3%A3%E2%80%B0-green-blend

[E] Letter from Director of Nestlé Research Center in Lausanne, Switzerland, stating the importance of the research of Prof **Williamson** to Green Blend coffee.

[F] Confidential 311-page dossier on coffee and health entitled “Nestlé R&D: Beneficial physiological effects of coffee polyphenols” on which Prof Gary **Williamson** is listed as a contributor. The date of the document is February 2011. This is available but is a confidential document.

[G] Reuters article on Nestlé’s 2009 annual results.
http://uk.reuters.com/article/2010/02/19/us-nestle-idUSTRE61I1MK20100219

[H] Transcript of first quarter conference call by Head of Investor Relations, Nestlé S.A. (April 2010).
http://www.nestle.com/asset-library/Documents/Library/Presentations/Sales_and_Results/2010_Q1Saltes_Confcall_Transcript.pdf