

Institution: University of Glasgow (UofG)		
Unit of Assessment: UoA 3 (Allied Health Professions, Dentistry, Nursing and Pharmacy)		
Title of case study: Developing innovative food products to improve UK nutrition through 'Health by Stealth' approaches		
Period when the underpinning research was undertaken: 2011–present		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s): (1) Dr Emilie Combet; (2) Prof Mike Lean.	Role(s) (e.g. job title): (1) Lecturer in Nutrition; Senior Lecturer in Nutrition; (2) Chair of Human Nutrition.	Period(s) employed by submitting HEI: (1) 2009–2016; 2016–present; (2) 1990–present.
Period when the claimed impact occurred: August 2013–present		
Is this case study continued from a case study submitted in 2014? Yes (UoA 1)		
<p>1. Summary of the impact UofG researchers collaborated directly with two UK companies to transfer knowledge and develop innovative products, creating 'Health by Stealth' approaches to nutrition. With Eat Balanced, they reformulated pizza to meet nutritional recommendations. This pizza is marketed to the mass catering sector [text removed for publication], with the 2,000,000 portions sold annually removing 544kg of salt and 340kg of fat from the food supply. With Seaweed & Co, they demonstrated seaweed as a versatile ingredient for flavour and iodine supply. This company markets two product ranges addressing iodine insufficiency, which are sold to the public and food/beverage manufacturers [text removed for publication].</p>		
<p>2. Underpinning research Human Nutrition comprises a body of integrated science with broad implications for public health and the economy. Dr Emilie Combet and Prof Mike Lean have recognised expertise in nutrient profiling as a primer for food reformulation; dietary interventions to assess the impact of food products on health; and designing tools to support public health initiatives (e.g. Eatwell Week for Food Standards Scotland).</p> <p>Despite campaigns to promote healthy eating, many people in the UK still consume energy-dense micronutrient-poor diets. To address this problem, Combet and Lean have built ongoing collaborative research relationships with key science-driven commercial partners to deliver 'Health by Stealth' through two linked innovative approaches. This research has translated into products that offer nutritional benefit without the need for behavioural change.</p> <p>Development of a nutritionally balanced pizza Estimates suggest that the UK pizza market is worth GBP3,285 million annually. In 2011, after initial profiling revealed lack of nutritional balance in ready meals [3.1], Combet and Lean profiled the nutritional contents of 25 Margherita pizzas commercially available from UK and international suppliers [3.2]. Their findings indicated very poor micronutrient and macronutrient balance among these products, plus high levels of salt and saturated fat. With Margherita pizzas representing a key ready-meal segment consumed across all age groups (but particularly by young people through schools catering), a GBP5,000 'First Step' award from Scottish Enterprise enabled Combet and Lean to offer nutritional expertise to Glasgow-based food company Eat Balanced to develop a frozen Margherita pizza that provides 30% of the daily requirement for energy intake and recommended amounts of all 27 essential nutrients [3.2]. The approach taken by Combet and Lean involved reformulating the initial pizza recipe to meet nutritional standards, focusing on nutrient intakes recommended for school-aged children and adults. The challenge of meeting the recommendation for iodine—a nutrient often in short supply in the UK diet—was solved 'by Stealth' using powdered Hebridean seaweed as an iodine-rich ingredient, with the added benefit of its savoury 'umami' taste overcoming the lack of flavour associated with reduced-sodium foods. The proof-of-concept pizza was tested for taste, appearance and acceptability among 63 children and 49 adults in two urban areas from either end of the socioeconomic spectrum [3.2]. Most participants rated the nutritionally balanced pizza as "<i>at least as good as their usual choice</i>". In 2015, Combet and Lean developed a programme of research on public perceptions of the language used to communicate concepts linking health, foods, meals and the overall diet [3.3], which complemented the 'Health by Stealth' approach.</p>		

Seaweed as a novel ingredient to tackle dietary iodine insufficiency

The trace element iodine is essential for the synthesis of thyroid hormones, which act as key regulators of neurodevelopment during pregnancy, and metabolism throughout life. Although iodine is naturally present in certain foods (e.g. milk, eggs, fish, seafood), insufficiency of this micronutrient has been highlighted as a global public-health issue, with the UK ranked seventh in the top 10 iodine-deficient countries worldwide. Consequently, a need exists to find novel solutions to this growing problem, which is caused, in part, by changes in eating habits such as the adoption of dairy-free diets (including vegan); poor uptake of fish as a food in the UK; absence of iodine prophylaxis; and lack of awareness of iodine insufficiency [3.4].

Seaweed is rich source of iodine that is commonly used in Asian cuisine; it is also an emerging industry for Scotland, with important economic implications for coastal communities. Following successful integration of powdered Hebridean seaweed as an acceptable ingredient in the reformulated pizza [3.2], Combet and Lean received a GBP23,000 Technology Strategy Board (now 'Innovate UK') feasibility award ([130725/13664-84264](#)) to collaborate with UK-based commercial partners Napiers the Herbalists (retail vendor of health and wellbeing products) and Seagreens (supplier of seaweed for the prototype pizza) on defining the contribution made by seaweed to iodine status. This work involved Dr Craig Rose, who was originally at Seagreens but later founded **Seaweed & Co** (Whitley Bay, Tyne and Wear). The feasibility study proved the efficacy of seaweed as a vector to address iodine insufficiency through low-level supplementation, with no adverse impact on thyroid function [3.5]. Published in 2014, this research evaluated *Ascophyllum nodosum*, an edible seaweed found in abundance around the UK coastline. Formulated as a 0.5g capsule (approximately 356µg of iodine), the seaweed was taken daily by a group of non-pregnant women aged 18–46 years, whose habitual iodine intake was reported as low when using a validated [food frequency questionnaire](#) developed by Combet and Lean in 2014. Despite low bioavailability of encapsulated seaweed, urinary iodine concentration after the 2-week intervention rose to levels consistent with iodine sufficiency (>100µg/L). Participants said the supplement was easy to use and had an acceptable taste.

The feasibility study indicated that seaweed supplementation might offer an effective solution to UK dietary iodine insufficiency [3.5]. Nonetheless, toxicity arising from excessive ingestion of iodine poses a potential hazard, particularly among people with pre-existing thyroid disorders. In 2014, Combet conducted a survey capturing the emerging market of edible seaweed products available online and/or in store from 29 UK supermarkets and specialist shops, either as whole foods or ingredients [3.6]. This research focused on product labelling for iodine content. Of the 224 products identified, only 22 gave information about the iodine content and 40 provided sufficient information to estimate the iodine content. Notably, 26 of the seaweed products available in the UK market could potentially cause iodine intake above the recommended tolerable levels (>600µg/L).

Combet and Lean maintain close relationships with Eat Balanced and Seaweed & Co. This association has evolved to ensure that all three parties keep an open dialogue about upcoming research and development opportunities, as well as regulatory changes in public health and food safety. The relationship with Seaweed & Co provides a constant feedback–feedforward loop around concerns about regulation and toxicity of seaweed products, with Combet continuing to work with the company on bioavailability of iodine from seaweed, a key factor in understanding the potential risk for overexposure (and how to prevent it). In addition, a GBP79,000 Innovate UK grant ([133109/94307-562612](#)) was secured in 2017 to investigate the Eat Balanced pizza as a vehicle for iodine prophylaxis through 'Health by Stealth'.

3. References to the research

1. Celnik D, Gillespie L, **Lean M** (2012) Time-scarcity, ready-meals, ill-health and the obesity epidemic. *Trends Food Sci Tech*;27(1):4–11 (doi:[10.1016/j.tifs.2012.06.001](#)).
2. **Combet E**, Jarlot A, Aidoo K, **Lean M** (2014) Development of a nutritionally balanced pizza as a functional meal designed to meet published dietary guidelines. *Public Health Nutr*;17(11):2577–2586 (doi:[10.1017/S1368980013002814](#)).

3. Buckton C, **Lean M**, **Combet E** (2015) 'Language is the source of misunderstandings'—impact of terminology on public perceptions of health promotion messages. *BMC Public Health*;15:579 (doi:[10.1186/s12889-015-1884-1](https://doi.org/10.1186/s12889-015-1884-1)).
4. **Combet E**, Bouga M, Pan B, **Lean M**, Christopher C (2015) Iodine and pregnancy—a UK cross-sectional survey of dietary intake, knowledge and awareness. *Br J Nutr*;114:108–117 (doi:[10.1017/S0007114515001464](https://doi.org/10.1017/S0007114515001464)).
5. **Combet E**, Ma Z, Cousins F, Thompson B, **Lean M** (2014) Low-level seaweed supplementation improves iodine status in iodine-insufficient women. *Br J Nutr*;112(5):753–761 (doi:[10.1017/S0007114514001573](https://doi.org/10.1017/S0007114514001573)).
6. Bouga M, **Combet E** (2015) Emergence of seaweed and seaweed-containing foods in the UK: focus on labelling, iodine content, toxicity and nutrition. *Foods*;4(2):240–253 (doi:[10.3390/foods4020240](https://doi.org/10.3390/foods4020240)).

4. Details of the impact

Combet and **Lean** have collaborated directly with commercial partners to transfer knowledge and facilitate development of new products that address UK nutrition through 'Health by Stealth'. The UofG contribution to these partnerships focused on **(1)** reformulation of Margherita pizza to meet nutritional recommendations, and **(2)** proof-of-concept demonstration that seaweed offers a versatile ingredient for flavour, and to boost iodine flux in the food supply. This body of work provided economic benefits for **Eat Balanced** and **Seaweed & Co.** Suppliers, manufacturers and customers of these two companies are secondary beneficiaries of the research. In addition, **Combet** has raised public awareness of dietary iodine.

Eat Balanced provides nutritionally balanced products for the mass catering sector

Eat Balanced offers 'Health by Stealth' food solutions to help children eat a balanced diet [5.A, 5.B]. UofG research [3.1, 3.2] underpinned reformulation and taste testing of a nutritionally balanced frozen Margherita pizza (2011). Eat Balanced subsequently took the pizza forward from prototype to market, with **Lean** appointed as the company's Chief Scientific Officer. Eat Balanced launched a range of pizzas in two UK supermarkets and an online grocery retailer in September 2012 (outlined in a [REF2014](#) impact case study). A year on, Eat Balanced shifted its business model to the mass catering market. This change was prompted by the hostile environment that many small food companies experience in the retail grocery sector regards per-unit pricing and in-store promotions [5.A].

The Eat Balanced Margherita pizza (marketed as 'Pizza Power') is available as a 5-inch individual portion and a 15-inch by 11-inch multiportion version [5.B]. More than 2,000,000 portions (85g per portion) are sold annually, with gross sales of [text removed for publication] recorded in the 2019–2020 financial year [5.A]. The success of Pizza Power has encouraged Eat Balanced to develop a second nutritionally balanced product. The company worked with a chef and Scottish food manufacturer MacPhie of Glenbervie to create 'Passata Power', a concentrated tomato and vegetable sauce [5.B]. This product was ready to launch in 2020, but marketing stalled as COVID-19 restrictions hit mass catering in schools and hospitality.

UofG research demonstrated that the public find different terms or messages used around food and health confusing, particularly what constitutes a nutritionally balanced diet [3.3]. This evidence bolstered the 'Health by Stealth' approach championed by Eat Balanced, which overcomes this problem through providing complete meals designed to be nutritionally balanced, without compromise on taste. Eat Balanced products meet the 2008 Nutritional Requirements for Scottish schools [5.B]. When compared with a standard frozen pizza (supplied by Brakes) [5.B], annual sales of the Eat Balanced pizza potentially remove 544kg of salt, 340kg of fat (of which 170kg is saturates) and 153kg of sugar from the mass catering food supply, while adding 4,760kg of protein and 2,720kg of fibre. Eat Balanced products are certified by the Soil Association 'Food for Life' programme [5.B], which promotes ways to ensure good food is the easy choice for everyone. In addition, the Eat Balanced Founder/CEO sits on the board for the Scottish Government Food Commission [5.B], which is tasked with making Scotland a 'Good Food Nation' by 2025.

The Trussell Trust has identified high levels of food poverty in Scotland, with over 210,000 emergency food parcels distributed during April 2018–March 2019 (a 23% increase on the previous year). In Glasgow alone, 14,656 children received help from food banks. The struggle to access and/or afford nutritionally balanced food intensified during 2020 owing to COVID-19 lockdown measures, and the subsequent economic crisis. In May 2020, Eat Balanced donated supplies of Passata Power to Glasgow-based charity Launch Foods, which enabled more than 10,000 hot meals to be prepared for distribution to vulnerable children [5.A].

Pizza Power has been manufactured in partnership with The Victor Pizza Company (Glasgow) as part of its Gusto range since 2014 [5.C], with the Hebridean seaweed used to replace salt, and to add flavour and nutrients (including iodine) to the dough, supplied by Seaweed & Co. The partnership with Eat Balanced has helped The Victor Pizza Company to expand and upgrade its production capability. In July 2019, it received a GBP152,000 Regional Selective Assistance grant from Scottish Enterprise to create 15 full-time jobs and safeguard 7 existing jobs over the next 3 years [5.C]. On announcing this grant, Scottish Enterprise highlighted that The Victor Pizza Company was *“the only pizza manufacturer to use seaweed in a range of bases to provide a healthy, balanced alternative to traditional dough”* [5.C].

Pizza Power is supplied to the UK food services industry by large wholesale companies (e.g. Brakes, Bidfood) [5.B]. These links to the procurement chain for mass catering democratise access to Eat Balanced products for individuals most likely to benefit from the ‘Health by Stealth’ approach (e.g. children from low socioeconomic backgrounds). In addition, the public health benefits can be better delivered through procurement rather than traditional retailing (e.g. supermarkets), both in terms of reach and per-unit cost. Eat Balanced customers include schools (council and independent), pubs, restaurants, family venues, leisure centres, tourist sites and corporate caterers [5.A, 5.B]. Primary and secondary schools represent 70% of the total volume of Pizza Power sales [5.A]. A Catering Manager from East Lothian Council highlighted its convenience for mass catering: *“We’d previously been making pizzas from scratch, but decided to give Pizza Power Kids a go when we heard about their health credentials. We trialled the pizzas in various Primary schools and the kids loved them. It saves us over 2 hours compared to making from scratch and they are very affordable”* [5.B, 5.D]. In June 2016, UK pub chain Fuller’s launched a healthy kids’ menu in 136 pubs. According to its Executive Chef: *“This is the first time we have featured pizza on our kids’ menu. We go to great lengths to source fresh and high quality foods for our adult’s menus as well as our kids’ menu. We’ve worked hard to deliver dishes with low salt content. The seaweed used in Pizza Power Kids to replace salt, is a brilliant idea, and you can’t see it or taste it. Along with the other innovative ingredients, it’s a great product”* [5.D].

Seaweed & Co develop seaweed-based products to target iodine insufficiency

The global seaweeds market was valued at USD10.31 billion in 2015, with human consumption accounting for 81% of total revenue. Consequently, UK producers and suppliers are seeing commercial opportunities as the profile of seaweed products grows. Since 2014, **Combet** and **Lean’s** research [3.4–3.6] has contributed to the growth and development of Seaweed & Co by reinforcing the weight and credibility of the health benefits attributed to its products [5.E]. Their work also provided proof of concept that using seaweed in pizza dough could be an effective way to increase iodine in the food supply ‘by Stealth’ [3.2]. The Managing Director of Seaweed & Co confirms that these UofG projects have provided *“extremely positive impacts on the business through the demonstration of the benefits of our PureSea range of seaweed ingredients to be utilised in food and nutrition products to provide a natural iodine source. The research data provides positive insights for our customer base to confidently utilise PureSea ingredients in their products, and gives credibility to the benefits of PureSea’s nutritional attributes (in terms of a natural good source of iodine). Dissemination of the research activity has been undertaken throughout our sales network and resulted in projects with existing and new customers. This has included projects in North America, across Europe, and a new relationship with distributors in Asia. We have recently recruited two new people to support production and sales activities as volumes start to increase significantly”* [5.E].

Seaweed & Co has developed two product ranges ('Weed & Wonderful' and 'PureSea') [5.F]. Company turnover was [text removed for publication] during 2016–2020, with [text removed for publication] turnover predicted for the 2020–2021 financial year [5.E]. The micronutrient benefits of seaweed as a natural source of iodine are the primary focus of marketing information provided on the company website [5.F], with UofG research cited both directly [3.6] and indirectly. The Weed & Wonderful range includes seaweed capsules and infused oils marketed to the public, either direct from the Seaweed & Co website [5.F] or from retailers such as Boots, Holland & Barrett and the QVC TV shopping channel [5.F, 5.G]. PureSea Natural is the core product in the ingredient range, which can be used for salt replacement, flavour enhancement and nutritional improvement across a range of foods and beverages [5.F]. PureSea products clearly label the known quantity of iodine, a major quality and safety advantage over some competitor products to prevent overconsumption [3.6]. This range is marketed to customers in the food and beverage manufacturing sector, including Eat Balanced and PepsiCo [5.E]. These products are sold via distributors such as LEHVOSS Nutrition (across Europe for nutraceutical markets) and Univar Solutions (across Europe, Asia and the Middle East for food markets) [5.G].

Growing demand for raw materials by companies such as Seaweed & Co has created economic benefits for seaweed suppliers. The Hebridean Seaweed Company (Stornoway, Isle of Lewis) harvests and processes the *Ascophyllum nodosum* used in Seaweed & Co products. In 2018, the Hebridean Seaweed Company received GBP800,000 from the European Maritime and Fisheries Fund to construct a new factory, with an additional GBP659,000 provided by Highlands and Islands Enterprise (2019) [5.H]. This facility will benefit the local economy by doubling the number of employees to 26.

Raising public awareness of dietary iodine

Combet's research on iodine absorption was featured on the BBC programme *Trust Me, I'm a Doctor*, in a segment entitled 'What's the best way to get iodine in your diet?' (series 7, episode 4) [5.I]. The content highlighted the importance of dietary iodine, and demonstrated the differences in iodine absorption between milk, fish and seaweed (experiment designed and run by Combet). The episode aired on 23 January 2018 to an audience of 3.84 million UK viewers (live and via the BBC online catch-up service). An associated BBC microsite summarising the programme content received 4,300 unique views in the following 6 months, with viewers spending an average of 1 minute 39 seconds on the site [5.I]. Combet is also a member of the UK Iodine Group, an independent body that aims to eradicate iodine insufficiency through raising awareness of this nutrient and the consequences of dietary deficit.

5. Sources to corroborate the impact (PDFs uploaded for all listed items)

- A. Testimonial from the Founder/CEO of Eat Balanced.
- B. Eat Balanced: (1) The company [website](#) provides information on products, the supply chain and key customers, including testimonials; (2) Pizza Power marketing brochure. See pg. 5 for the nutritional content of the Eat Balanced and Brakes pizzas.
- C. The Victor Pizza Company: (1) Product [list](#). See p.2 for Eat Balanced pizzas; (2) [Press release](#) from Scottish Enterprise (July 2019).
- D. Eat Balanced customers: (1) East Lothian Council [YouTube [video](#)]; (2) [Fuller's](#) pub chain.
- E. Testimonial from the Managing Director of Seaweed & Co.
- F. The Seaweed & Co [website](#) provides information on products, retailers and nutritional benefits, including weblinks to Bouga and Combet [3.6].
- G. Seaweed & Co retailers and distributors: (1) [Boots](#); (2) [Holland & Barrett](#); (3) QVC TV shopping channel; (4) [LEHVOSS Nutrition](#); (5) [Univar Solutions](#).
- H. [Press release](#) confirming funds for the Hebridean Seaweed Company factory.
- I. BBC broadcast: (1) BBC *Trust Me, I'm a Doctor* [microsite](#), with video content featuring Combet; (2) BBC broadcast viewing figures and microsite statistics.