Satiety Control Through Food Structures Made by Novel Processing:
Generating Novel Food Structures to Aid Consumer Weight Management

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Liverpool Obesity Research Network (LORN): www.liv.ac.uk/obesity
1. Develop food products that help regulate food intake by accelerating satiation during a meal, enhancing satiety, and/or reducing appetite.
2. Use novel processing methods and guarantee food safety.
3. Efficiency has to be proven in human trials against biomarkers of satiety and/or appetite.
4. The effect on nutrient bioavailability has to be measured.
5. Multidisciplinary collaboration in food processing, nutrition and consumer science with food producing enterprises will be instrumental.
Background - Area 2.2.3 Food processing

Optimising innovation in the European food industry through the integration of advanced technologies into traditional food production including fermented food, tailored process technologies to enhance the functionality, quality and nutritional value of food including organoleptic* aspects in food production including new foodstuffs.

*Enhancing sensory properties (taste, colour, odour and feel) of food through processing
The Consortium

7 SME’s

Advisory Board

Satin
Satiety Innovation

7 Universities

Satin consortium

5 Industry Partners

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Despite advances in the
i) measurement of appetite expression and the biomarkers underpinning the processes of satiation and satiety,
ii) understanding of the impact of nutrient composition
iii) knowledge of the physical characteristics of food on eating behaviour

Few satiety-enhancing products have successfully remained in the European market, due to the failure of producing effective and appealing products.
The SATIN consortium aims to develop novel food products for European consumers through processing innovation that will enhance satiety and help to achieve a balanced diet.

The multidisciplinary collaboration will develop food products that help regulate food intake by accelerating satiation during a meal, enhancing satiety and/or reducing appetite through novel processing methods and validate these products in human trials by examining key biomarkers, nutrient availability and behaviour.
Satiation and Satiety

Finlayson & Blundell 2012

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The Satiety Cascade

The satiety cascade allows us to conceptualise the processes that start, sustain and terminate a meal, and those that suppress further consumption.

It also illustrates the structure of behaviour and the mechanisms underpinning appetite expression.

(Blundell circa 1984)
SATIETY CASCADE

**Meal Quality**
- Consumer appeal
- Flavour
- Texture
- Nutrient

**Meal Quantity**
- Oral metering
- Osmotic load
- Gastric stretch
- Gastric emptying

**Nutrient status**
- Microbiota
- Gut biomarkers
- Nutrient absorption
- Substrate oxidation

**Cognitive Sensory**
- Pre-prandial motivation

**Pre-Absorptive**
- Termination of meal
- Inhibition of food intake
- Onset of next meal

**Post-Absorptive**
- Oral metering
- Osmotic load
- Gastric stretch
- Gastric emptying

**Nutrient status**
- Microbiota
- Gut biomarkers
- Nutrient absorption
- Substrate oxidation

Food

SATIATION

Satiety

SATIATION

Finlayson & Blundell, 2012

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Objectives

1. **Integrate advanced technologies** to screen novel food structures through in vitro models to isolate and refine products according to their satiating potential.

2. **Develop novel food processing technologies** that combine active ingredients and changes in food structure to produce a range of novel satiety enhancing ingredients.

3. **Produce finished food products** that pass through safety analysis, early sensory evaluation and consumer testing.

4. **Demonstrate the effects of prototype products** on biomarkers of satiety and on nutrient bioavailability using in vivo studies and validating new in vivo approaches.

5. **Demonstrate the effects of final food products** on within-meal satiation, post-meal satiety and/or reduced appetite using biomarkers of satiety.

6. **Demonstrate the enduring effects of individual food products** on satiety and their potential to induce weight loss.

7. **Demonstrate the long-term consumer and health benefits** of adhering to a diet containing satiety-enhancing products.

8. **Validate health claim endpoints and commercialisation opportunities.**
WP 1 will develop and validate new in vitro gastrointestinal models that analyses satiety biomarkers to assay novel ingredients, refine prototype food structures, and assess nutrient bioavailability to assist product development. The work package developed will comprise two fundamental components:

1. an artificial, dynamic gastrointestinal model which simulates the different intestinal regions and allows evaluation of the intestinal fate of food ingredients and characterization of metabolic processes which may alter their biological activity profile.

2. a set of functional in vitro assays that can be used on automated screening platforms, for the detection of interactions between food components and gastrointestinal chemosensors and gastrointestinal hormone secretion pathways.

DELIVERABLE: production of in vitro bioactive profiles of new prototype products to assist the choice of those to be further developed and tested through the project.
This WP will develop novel food processing technologies combining optimised food structures and flavours with active ingredients that are able to enhance satiation/satiety.

We will develop food products using novel processing techniques. Resulting modified existing whole foods will be assessed for their satiation and early satiety potential. In addition, various products will be formulated to include potentially active satiety components as assessed in WP1 and WP3.

**DELIVERABLE:** Production of finished products that pass through safety analysis, early sensory evaluation and consumer testing. **We will produce consumer- and safety-test effective final formulations for clinical evaluation in WP4 and WP5.**
It is essential to study new food components within the gut, both to understand their potential effects on satiety and to ensure safety.

Food components that are not digested in the upper gut (e.g. dietary fibre) become available to the vast numbers of microorganisms that inhabit our large intestine. Some of the products of microbial activity may also contribute to satiety, and may therefore help to explain the satiating effects of certain food components.

**DELIVERABLE**: Information from in vitro and in vivo analyses predicting the colonic fermentability of new dietary components, their safety and the impact on hormone signalling
WP4 – Validation of Satiating Dietary Components of Short- & Medium-Term Eating Behaviour

WP4 will assess the effects of food and beverage products on the control of appetite. This will involve the identification of key processes controlling food consumption.

A strong and sensitive methodological platform has been established to detect the effects of foods/beverages on the operations of the Satiety Cascade. This system relates the physiological system (gastrointestinal peptides, microbiota, fermentation) and the action on eating processes and sensations that are associated with eating.

**DELIVERABLE:** This methodology will be further improved and extended to provide innovative and comprehensive procedures to detect the action of foods on hunger/fullness and food preferences. The technical innovations and the framework will provide guidance for industry and EFSA.
Appetite

1. Must result in changes in energy intake (if this is claimed physiological effect rather than decreased body weight)
2. Must be sustained across day – no compensation
3. Must be enduring – observable e.g. Up to four weeks during dosing
4. Biomarkers useful for proof-of-concept but not necessary for efficacy
5. Appetite ratings must be assessed using VAS.

Appetite

1. Considered only in context of decreased body weight - *intake no longer as important but body weight is (most claims to date focus on intake – and are negative)?*
2. Must be sustained (12 weeks) with continuous consumption of food to exclude adaptation through compensatory mechanisms – *must have body weight change to make any communication on appetite (how many claims have actually been reviewed with body weight)?*
3. Biomarkers may support behavioural assessment
4. Behavioural assessment (appetite ratings) must be assessed using VAS.

‘Claims on changes in appetite ratings have been made in the context of body weight. In this context evidence for a sustained effect on appetite ratings and body weight with continuous consumption of the food, should be provided’

The purpose of generating satiety-enhancing processed food products is to help consumers achieve a balanced diet resulting in long-term beneficial effects in body weight and health. Large-scale clinical trials are required to demonstrate that changes in food structure can modify the mechanisms involved in the regulation of total energy intake, beneficially affecting energy balance and body weight regulation.

The proof of concept study in WP5 will be conducted in line with EFSA’s Draft Scientific Opinion on the scientific requirements for health claims related to appetite ratings and weight management.

DELIVERABLE: The ability to maintain a reduced body weight will be the primary outcome. In a sub group of subjects the sustained effects of these novel products on appetite/food intake will also be assessed.
Weight Management

1. Weight loss must be observed for at least 12 weeks with continuous consumption of food and be sufficient large not to be attributed to loss of water or lean mass
2. Weight regain prevention much be observed for 24 weeks after weight loss
3. Changes in appetite ratings, energy intake, energy expenditure or fat oxidation considered in support of mechanism to achieve weight reduction (if sustained effect) – *appetite can be used as supporting evidence*

‘Changes in energy intake etc have been proposed in the context of claims related to the reduction of body weight.

*Evidence for a sustained effect of any of these variables with continuous consumption of the food may be considered in support of mechanism by which the food may exert the claimed (BW) effect’*

The SATIN project and its results will be promoted as widely and as effectively as possible. The **four main stakeholder groups** that will be addressed are:

- Food & ingredients industry including SMEs
- Policy Makers and Regulatory
- Science & Research community
- Consumers and Consumer associations

The project will **generate results** of interest and use for European citizens as well as **Intellectual Property (IP)** of significant value.

**Dissemination tools** include a website and intranet, flyers, posters, factsheets, publications, presentation at and organisation of dissemination events (workshops, symposia, conferences) and an ongoing structured dialogue with the key stakeholders.
The SATIN consortium consists of seven SME (Axxam, BioActor, CTAEX, CTC, NIZO, RTD Services and ProDigest), four industry (Cargill, Coca-Cola, Juver and Naturex) and seven academic (Universities of Aberdeen, Copenhagen, Leeds, Liverpool, Murcia, Rovira i Virgili, and the Karolinska Institutet) partners with an industry advisory board (Beneo, Kraft Foods, Kellogg’s, Kemin Health, Fonterra, GlaxoSmithKline and Sensus). The project is co-ordinated by the University of Liverpool.
THANK YOU!
More information:

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