Targeted release of nutrients and tastants to manage obesity

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ANALYSIS
Bioavailability, stability, survival and interaction with gut microbiota

MICROBIOLOGY

HEALTH
Health effects of food, and the prevention and treatment of health concerns

CONSUMERS
Perception and sensory aspects, consumer preference and behaviour

REGULATION
Claims and novel foods, labelling and marketing strategy

FOOD LAW

PRODUCT

PSYCHOLOGY OF EATING
Food

- Science
- Students
- Innovation in primary or secondary sector

Centre for Healthy Eating and Food Innovation

Maastricht University
Campus Venlo
Obesity – current treatment

Obesity
➢ high health risks (IGT, CVD, low grade inflammation, etc)
➢ need for effective dietary treatment

normal

gastric bypass
Gastric bypass

- Small gastric pouch
- Nutrients directly delivered into jejunum/ileum
- Increase in release of satiety hormones (GLP-1 & PYY)
- Increase in satiety
- Decrease food intake
Obesity – dietary treatment?
**Ileal brake**

- Nutrients appear in the ileum, while in normal conditions, these nutrients are readily digested and absorbed in duodenum/jejunum.

- ‘Brake’ on food processing and food intake.

- First indications in humans after lipid infusion (Maljaars 2005-2010);
Which nutrients induce the ileal brake and reduce food intake in humans?

- 13 healthy volunteers
- Randomized cross-over design
- naso-ileal tube
- Infusion of:
  - Protein (5 or 15* g casein)
  - Carbohydrate (4 or 13* g sucrose)
  - Lipid (6* g safflower oil)
  - Placebo (water)

*equicaloric amounts; 52 kCal
Study day

Arrival + Check position

8:00

8:30

9:00

10:30

11:30

12:30

Breakfast with 
$^{13}$C octanoic acid 
(gastric emptying)

Gastric emptying
Gallbladder volume
Small bowel transit time

Ad libitum lunch

Test day finished

Satiation
**Results**

**Food intake**

P < 0.0001
Δ 147 kcal

**CCK - plasma**

**GLP-1 - plasma**

**PYY - plasma**
Conclusions first studies

- Ileal brake can be activated in healthy individuals
- Promising target for weight management
- Delayed digestion of nutrients needed
  - Nutrient encapsulation strategies
    - Commercial preparations
    - Design targeted release encapsulation
Protein encapsulation

Lipid encapsulation
Lipid encapsulation

Encapsulation of lipids to delay lipolysis and reduce food intake
‘From encapsulate design towards human application’

Meinou N. Corstens
Lipid encapsulation

Emulsion = safflower oil in alginate gel

± 0.02 mm  ± 1 mm
In yoghurt

✓ 33 overweight volunteers
✓ 2 test days (6 g encapsulated safflower oil vs. control)
✓ Effect on satiety and food intake

Screening
33 healthy volunteers
BMI 25 – 30 kg/m²
18 – 65 yr

≥ 7 d in between

Test day

10 h fasting
Standardized breakfast
Enriched yogurt
(n=2 | randomized)
Ad libitum meal

Test day 1
Test day 2

VAS score:
- Satiety feelings
- GI symptoms

10 h fasting

Food intake (kcal)

* p < 0.05
Δ 51 kCal

* VAS score:
  - Satiety feelings
  - GI symptoms

Active
Control

Active
Control

Active
Control

Active
Control

Active
Control
Conclusions macronutrients and ileal brake

- Consistent observations over many intubation studies
- Concept remains intact using targeted release encapsulates, although effects are small

Ongoing and future research:
- Optimize encapsulate (identify exact disintegration location)
- Create optimal food matrix
- Dose-response studies
- Long term intervention studies targeting weight management in obesity
Other targets for weight management

Cross-Species Comparison of Genes Related to Nutrient Sensing Mechanisms Expressed along the Intestine

Nikki van der Wielen\textsuperscript{1,2}, Mark van Avesaat\textsuperscript{1,3}, Nicole J. W. de Wit\textsuperscript{2}, Jack T. W. E. Vogels\textsuperscript{6}, Freddy Troost\textsuperscript{1,9}, Ad Masclee\textsuperscript{1,9}, Sietse-Jan Koopmans\textsuperscript{6,9}, Jan van der Meulen\textsuperscript{9}, Mark V. Boekschoten\textsuperscript{1,3}, Michael Müller\textsuperscript{7}, Henk F. J. Hendriks\textsuperscript{1,9}, Renger F. Witkamp\textsuperscript{7}, Jocelijn Meijerink\textsuperscript{2,4}

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Different tastants and low-caloric sweeteners induce differential effects on the release of satiety hormones.

Maartje C.P. Geraets,*, Freddy J. Troost,†, Wim H.M. Saris*
Do non-caloric tastants in the intestine induce satiety and inhibit food intake \textit{in vivo} in humans?

\textit{Intraduodenal infusion of a combination of tastants decreases food intake in humans}\textsuperscript{1}

\textsuperscript{1}Mark van Avesaat,\textsuperscript{2,3} Freddy J Troost,\textsuperscript{2,3} Dina Ripken,\textsuperscript{2,4,5} Jelmer Peters,\textsuperscript{5} Henk FJ Hendriks,\textsuperscript{2} and Ad AM Mascele\textsuperscript{2,3}

**Centre for Healthy Eating and Food Innovation**

**Food intake**

<table>
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<th>P</th>
<th>B</th>
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<td>500</td>
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*P < 0.05  
\( \Delta 102.4 \text{ kCal} \)

**Hunger**

![Graph A: Hunger](image)

**Fullness**

![Graph B: Fullness](image)

**Desire to eat**

![Graph C: Desire to eat](image)

**Satiety**

![Graph D: Satiety](image)
Summary tastants and food intake

- First human experiments suggest that taste receptors in the gut are involved in regulation of satiety and food intake
- Umami taste seems to affect feelings related to satiety, while other tastants may have stronger effects on food intake
- Further research needed to explore the potential of tastants in managing obesity
Take home messages

- The distal small intestine seems particularly sensitive for undigested nutrients; proof of concept of delayed digestion of lipids is established.

- Nutrient encapsulation, possibly including non-caloric tastants, is a promising new approach to manage obesity.
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