Scientific update on metabolic improvement aspects with Palatinose™ (isomaltulose)

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Disclosures

- Received isomaltulose from BENEO Gmbh. for my research projects conducted while at IMU.
- Received no funding from BENEO Gmbh. for this presentation
- The funders had no role in review search strategy, data extraction and collation.

Presentation outline

- Getting to know IM
- A rapid review of evidence (2018 onwards)
  - Body weight management
  - Postprandial glycaemic management
  - Novel cardio-metabolic risks
- Promising areas to explore
- State of translation/application
- Take home messages

IM: Isomaltulose

PP: Postprandial

PPG: PP glycaemia

INS: Insulin

The rush for sugar alternatives

Sugar (sucrose) plays an indispensable role in diet

Excessive sucrose intake causes PPG surge →NCD

Therefore, there is an urgent need for possible alternatives to sucrose

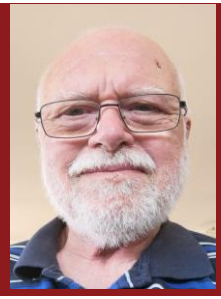
Uncertainty of non-nutritive sweeteners

IM is a promising alternative to sucrose due to its **suitable sweetness, potential physiological benefits, and feasible production processes**

Tian Y et al. Applied microbiology and biotechnology. 2019;103(21-22):8677-87.

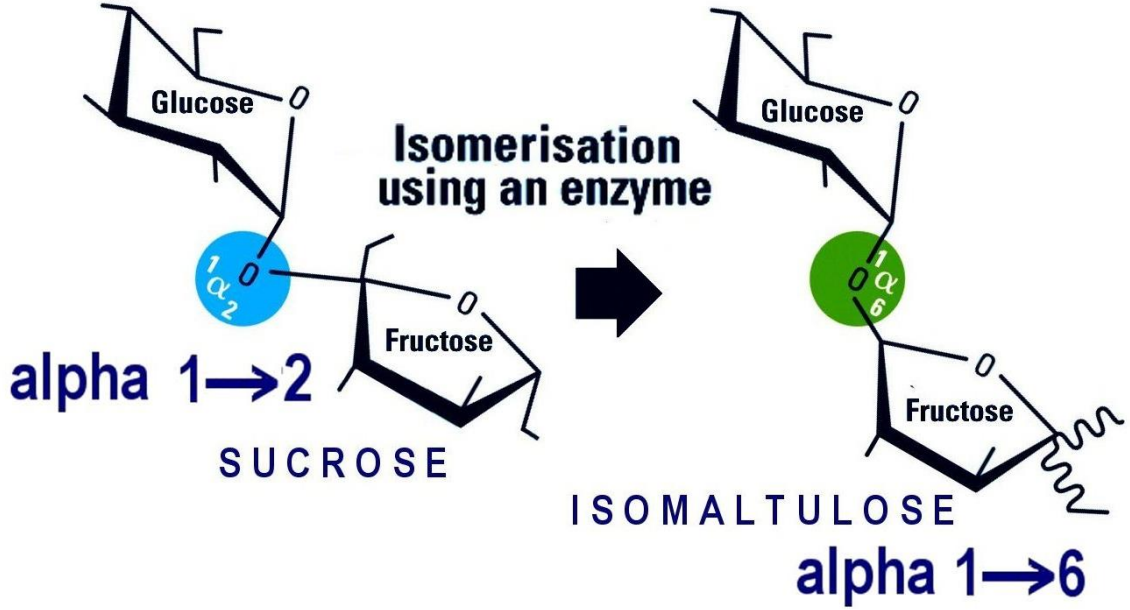
Lohner et al. Nutr J. 2017 Dec;16(1):1-21.

IM – A biochemist's delight



Prof Dr Peter Barling

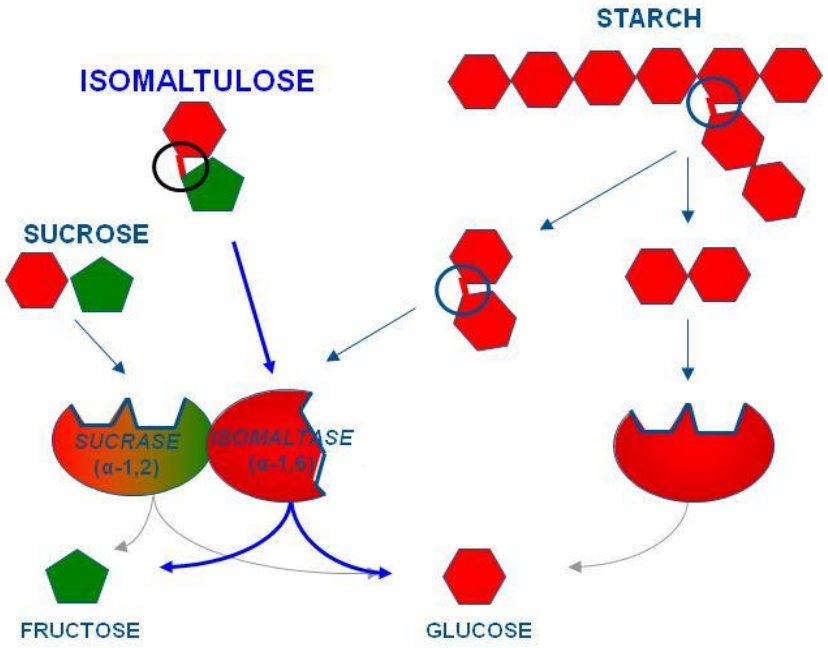
- Interesting disaccharide
- Like sucrose, composed of glucose and fructose
- But bonded differently
- A natural sweet constituent of honey



- Brand name: Palatinose™
- (6-0-α-D-glucopyranosyl-D-fructofuranose)
- CAS Reg. No. 13718-94-0
- Total molecular formula: $C_{12}H_{22}O_{11}$ x H_2O
- Molecular weight: 360.32

Meet the BOND

IM Digestion in small intestine

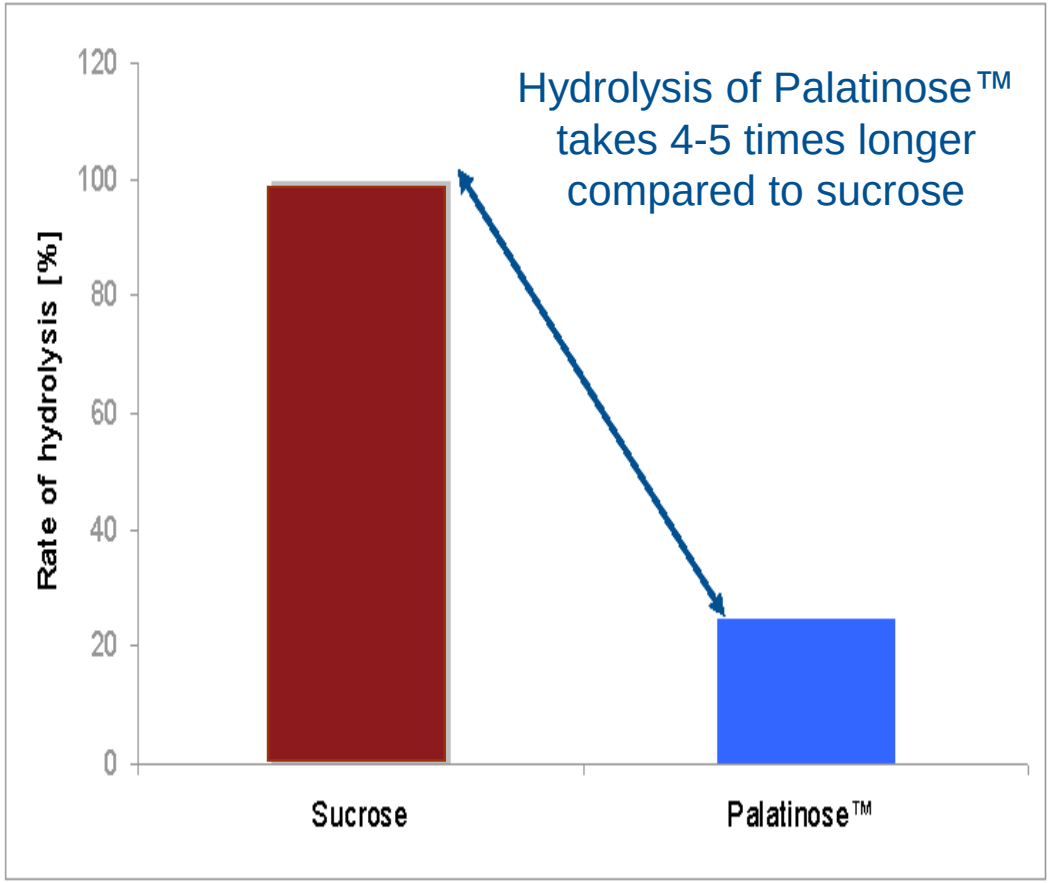


Scheme of hydrolysis of sucrose, starch & Palatinose™ in the small intestine

Isomaltulose is hydrolysed at the same enzyme complex involved in the digestion of sucrose and starch*

It is digested at the isomaltase site.

* The amylopectin derived glucose-glucose 1-6 linkage



Rate of hydrolysis – sucrose vs. Palatinose™ from *in vitro* enzyme kinetic studies

Palatinose™ (IM) is slowly released

- Is a "**slow-release**" carbohydrate
- Supplies glucose /energy at a **slower pace and over a longer period of time** vs. sucrose
- Is **completely digested**

For the Nutritionist: What is Isomaltulose?

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Dr Chang Sui Kiat

Isomaltulose: Recent evidence for health benefits

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AP Dr Amutha Ramadas

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ABSTRACT

Isomaltulose (IM) is a naturally occurring disaccharide composed of alpha-1,6-linked glucose and fructose monomers. IM is gaining interest as an alternative sweetener to sucrose primarily because of its low glycaemic index (GI) properties. Low GI has been implicated in the prevention and management of chronic diseases such as cardio-metabolic diseases and cancers. The low glycaemic potential of IM has fuelled the many recent *in-vitro*, animal and human studies including randomised-controlled trials and cohorts. This review discusses the chemical and physiological properties of IM in relation to its potential health effects, with a focus on its prebiotic properties. Research health findings from existing literature published within the last 10 years were compiled and summarised. The novel applications of products formulated with IM in improving health, cognition and

Cited 47 times

Time for an update? → Rapid update

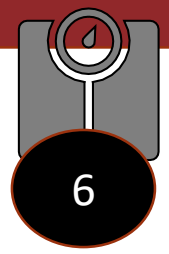
How were the studies scoped for this scientific update?

Search	Query	Results
#5	Filtering for human studies	**43**
#4	Search: (isomaltulose) OR (palatinose) Filters: from 2018 - 2023	121
#3	Search: (isomaltulose) OR (palatinose)	398
#2	Search: palatinose	398
#1	Search: isomaltulose	305

26 excluded
- Not IM (4)
- No health outcomes (11)
- Not original research (10)
- Mice (1)

17 included

Body weight management



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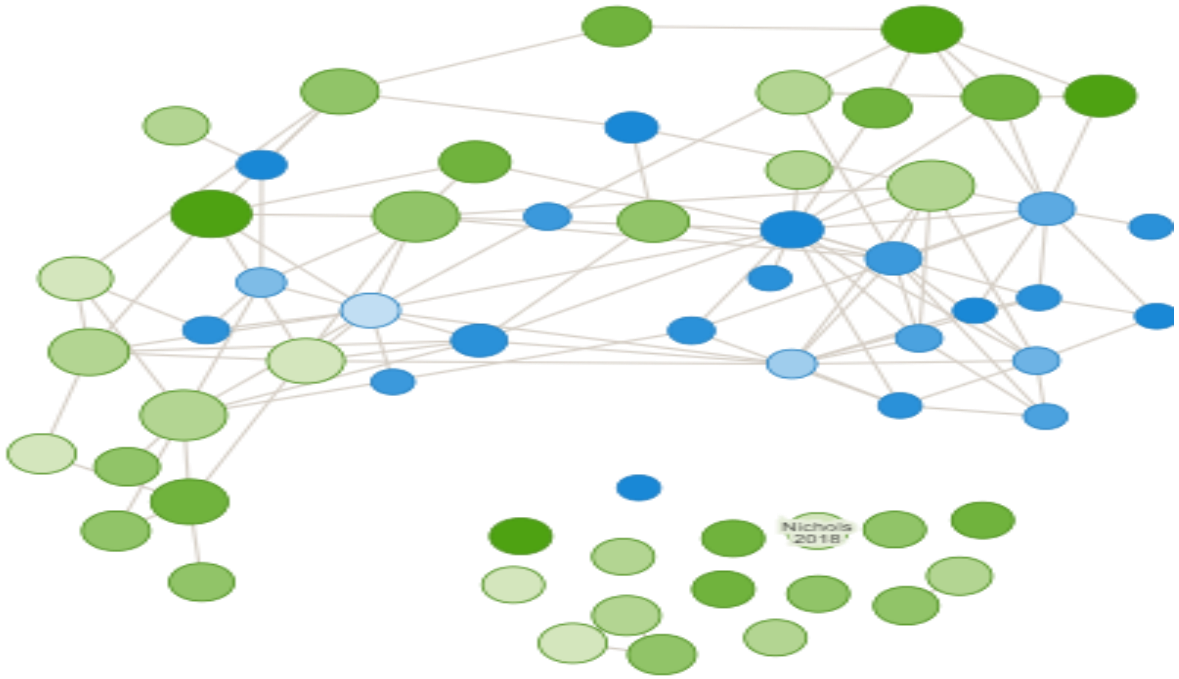
Postprandial glycemia & Insulinemia

15

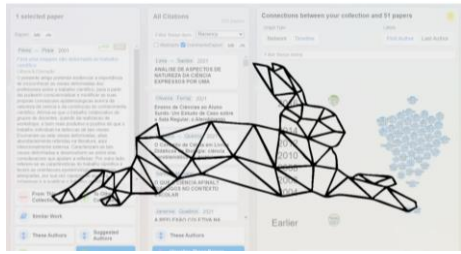
Novel cardiovascular risks

4

Bibliometric analysis



Search results validated using Research Rabbit



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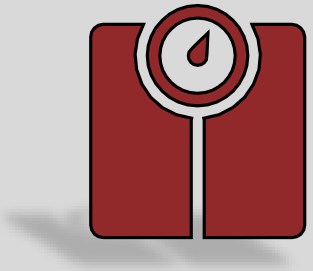
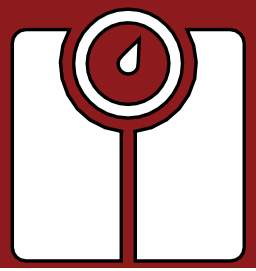


Isomaltulose & Body Weight Management

Body weight management



Reference	Country	Study design	Participants	Control	Body weight	Fat Oxidation	Energy Intake	Appetite
Notbohm et al (2021)	Germany	Randomised DB Cross-Over	21 male runners	Maltodextrin and glucose				
Kendall et al (2018)	New Zealand	Randomised DB Cross-Over	77 healthy adults	Sucrose				
Lightowler et al (2019)	UK	**12 week RCT**	64 healthy overweight/obese adults	Sucrose				
Mateo-Gallego et al (2020)	Spain	**10 week RCT (crossover)**	**41 T2DM with overweight/obesity**	Maltose			trend	
Deng et al (2021)	New Zealand	Randomised Cross-Over	55 healthy adults	Sucrose				
Dávila et al (2019)	Venezuela	Randomised DB Cross-Over	23 **T2DM** sver 50 years old	ONS std				

Both RCTS showed beneficial effects

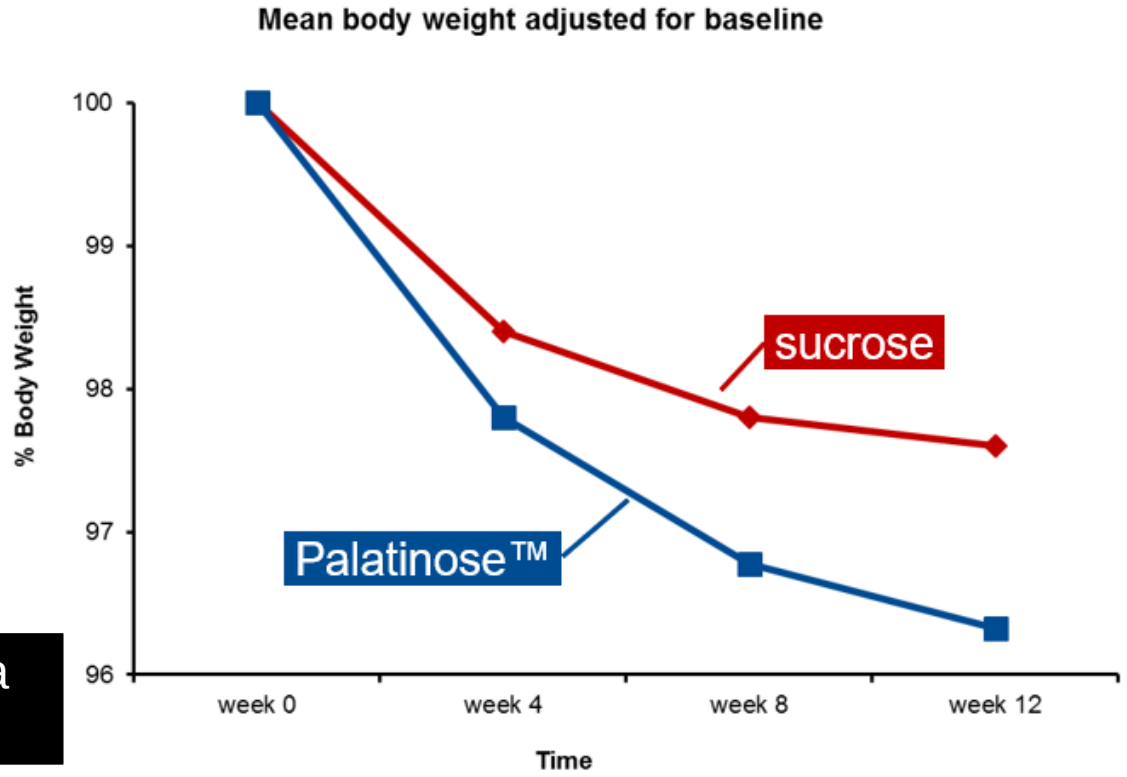
IM better than control

No sig effect

Control better than IM

IM and body weight- 12 weeks study

Randomized, Double-Blind, Controlled Trial
P: 64 healthy adults with Overweight/Obesity
I : 40 g/day IM added to an energy-reduced diet
C : 40 g/day sucrose added to an energy-reduced diet
O: Weight loss (fat mass loss, energy intake, fat oxidation)



IM may be more effective in **promoting weight loss** in a weight loss diet than sucrose

Lightowler et al . Nutrients. 2019 Oct 4;11(10):2367.

IM and satiety10 weeks study

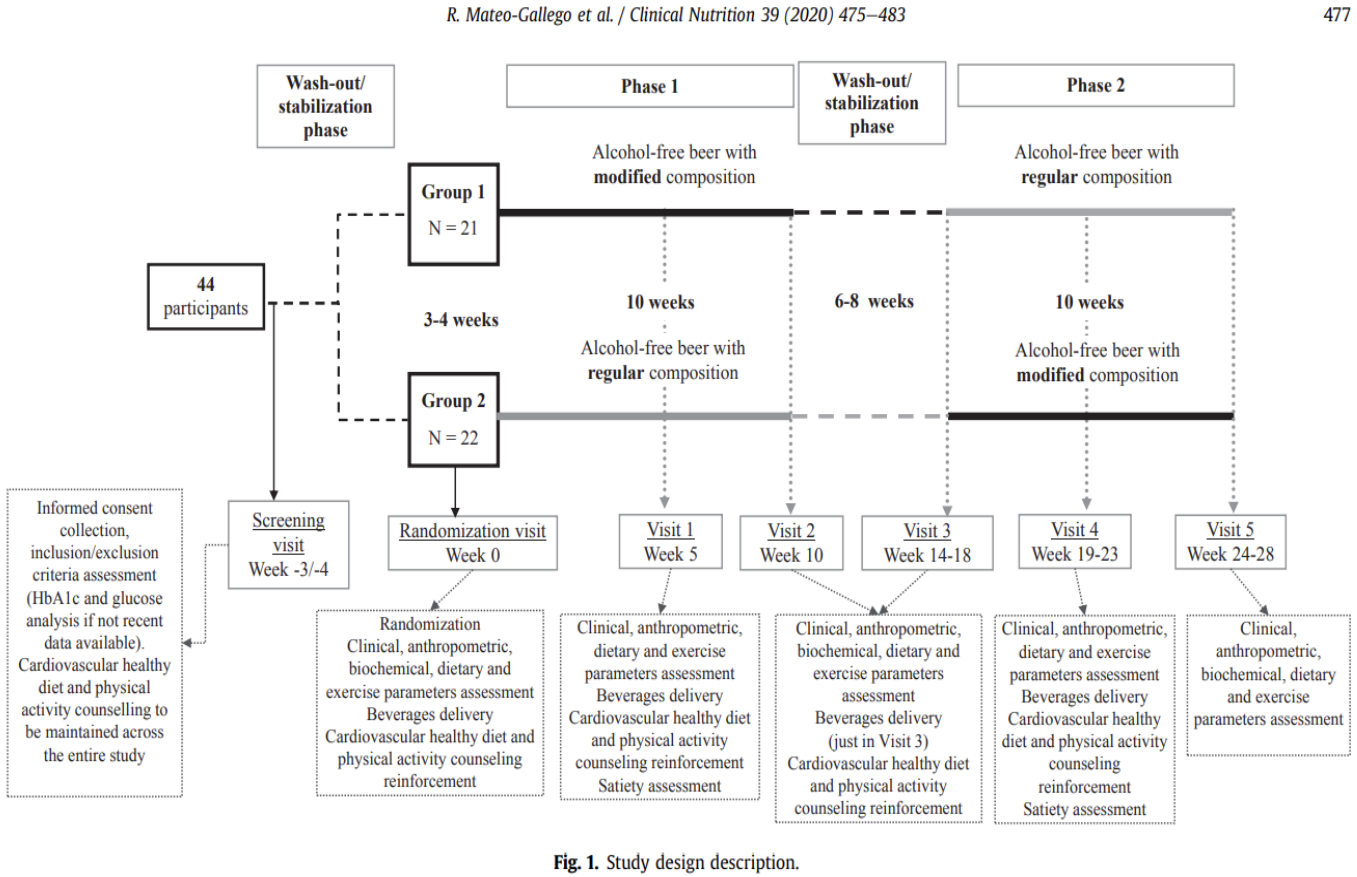


Fig. 1. Study design description.

Mateo-Gallego et al. Clinical Nutrition. 2020 Feb 1;39(2):475-83.

Randomized, Double-Blind, Controlled Trial

P: 41 T2DM with overweight/obesity
I : 16.5 g/day IM +5g maltodextrin added to 66cL alcohol-free beer
C : 66cL of regular alcohol-free beer
O: Biochemical markers, anthropometry, energy intake and satiety

- IM had significantly reduced appetite
- IM had a trend for lower energy intake specifically SFA
- IM significantly reduced insulin resistance
- IM may be more effective in **weight management in T2DM**

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Isomaltulose & Postprandial Glycemic Management

IM better than control

No sig effect

Control better than IM

Postprandial glycemia

Reference	Country	Study design	Population	Control	PPG	PP INS	GIP	GLP-1
Notbohm et al (2021)	Germany	Randomised DB Cross-Over	21 male recreational endurance runners	Maltodextrin and glucose				
Kendall et al (2018)	New Zealand	DB Cross-Over Study	77 healthy adults	Sucrose				
Kawaguchi et al (2018)	Japan	Randomised SB Cross-Over	**5 male patients with NAFLD**	Sucrose				
Kobayashi et al (2021)	Japan	Cross-Over	10 healthy middle-aged and older adult	Sucrose				
Keyhani-Nejad et al (2020)	Germany	Randomised DB Cross-Over	15 NGT, **10 IGT and 10 T2DM**	Sucrose				
Mateo-Gallego et al (2020)	Spain	**10 week RCT (crossover)**	**41 T2DM with overweight/obesity**	Maltodextrin and glucose				
Camps et al (2021)	Singapore	Randomised SB Cross-Over	12 healthy men	Sucrose				
Lamiquiz-Moneo et al (2022)	Spain	Randomised Cross-Over	10 + 20 healthy volunteers	Maltodextrin and glucose				
Sünram-Lea et al (2021)	Switzerland	Randomised Cross-Over	11 healthy children aged 5-7 years	Sucrose and glucose				
Kokubo et al (2022)	Japan	Randomised SB Cross-Over	**20 individuals with prediabetes**	Std ONS				
de Groot E et al (2020)	Ireland	Randomised DB Cross-Over	**80 overweight mildly hypertensive adults**	Sucrose	Late PP period			
Zhang et al (2023)	Germany	Randomised DB	**8-15 healthy adults & 9-13 T2DM**	Sucrose				
Marcchand et al (2020)	New Zealand	Randomised Cross-Over	65 healthy young adults	Sucrose				
Dávila et al (2019)	Venezuela	Randomised DB Cross-Over	23 T2DM > 50 years old	ONS std				

Predominantly consistent results

Gastric inhibitory polypeptide (GIP)
Glucagon-like peptide -1 (GLP-1)

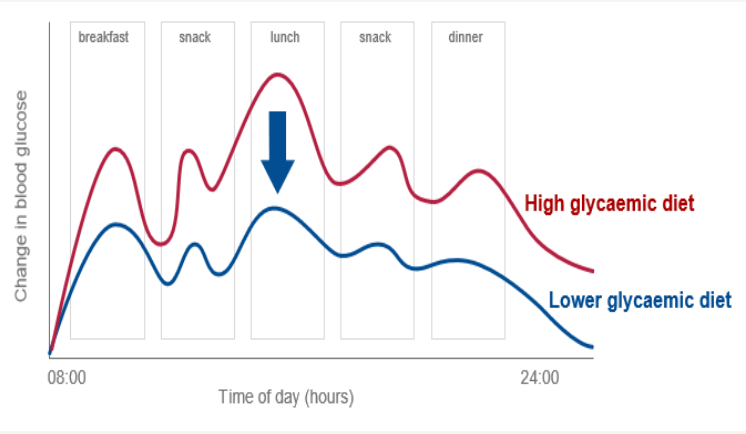
IM and beta-glucans as part of a low-GI diet

Foods used to construct the test meals provided in the study.

	LGL Ingredients	HGL Ingredients
Breakfast	*Yellow noodles (beta-glucan, 4.2%)*, spinach, minced pork, light and dark soya sauce, oil	*Yellow noodles (control)*, spinach, minced pork, light and dark soya sauce, oil
Lunch	*Parboiled basmati rice*, pork balls, sesame seeds, knorr seasoning, chamomile tea, *isomaltulose (25 g)*	*Glutinuous rice*, pork balls, sesame seeds, knorr seasoning, chamomile tea, *sucrose (25 g)*
Snack	Jelly, chamomile tea, *isomaltulose (55 g)*, oreo cookies	Jelly, chamomile tea, *sucrose (55 g)*, oreo cookies
Dinner	*Pad thai glass noodles with tofu*, wonton, chamomile tea, *isomaltulose (22 g)*, oil, *rice biscuits*	*Teriyaki chicken with rice*, wonton, chamomile tea, *sucrose (22 g)*, oil, *potato chips*

Different ingredient indicated in italic font; LGL: reduced GL; HGL: high GL.

In theory



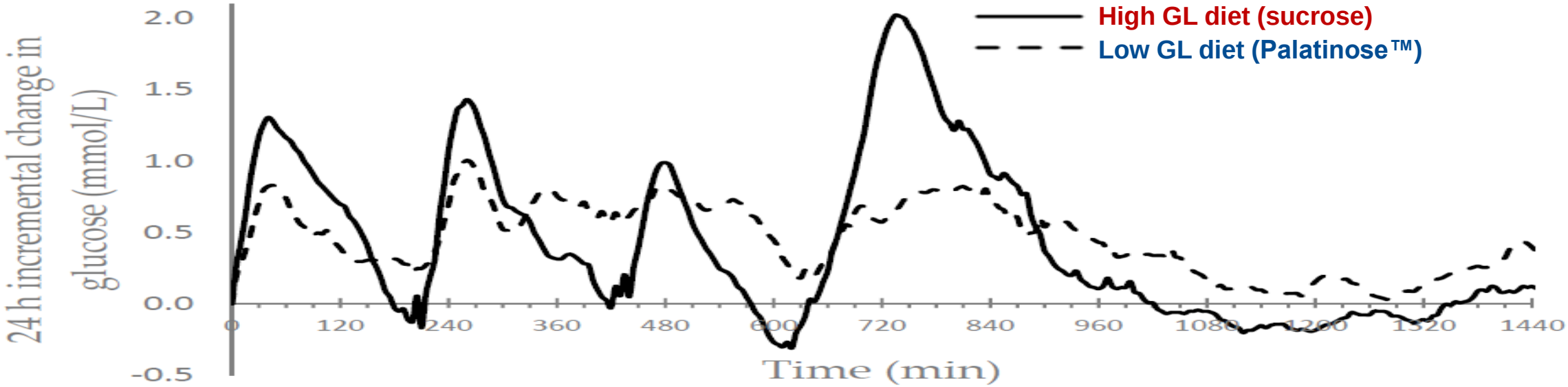
Study design: Randomised, single-blind, controlled, cross-over study in 12 healthy men

Camps SG, Kaur B, Lim J, Loo YT, Pang E, Ng T, Henry CJ. Nutrients. 2021 Sep 3;13(9):3102.

Proof of concept with Palatinose™ and beta-glucans
The low glycaemic concept works

Camps et al (2021)

The proof with Palatinose™



- Lower maximum glucose levels over 24 hr (p=0.0024) with the low GL diet, especially after dinner (p=0.0084)
- Balanced blood levels over 24 hr (p<0.0001); fewer swings in blood glucose as measured by MAGE

Curves mimic theoretical low GI blood glucose reponsecurves

Camps SG et al . Nutrients. 2021 Sep 3;13(9):3102.

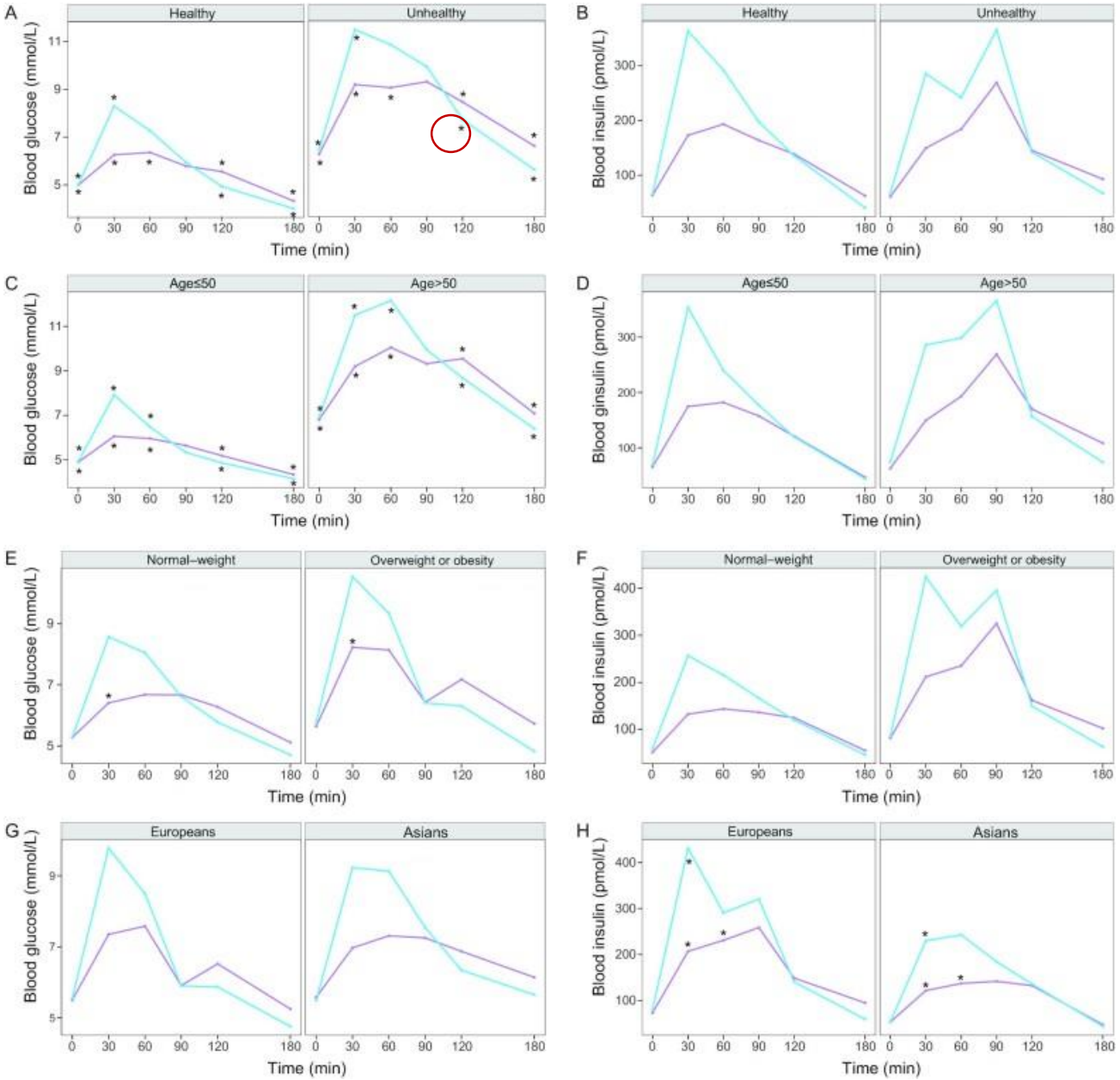
GL: Glycaemic Load
MAGE: Mean amplitude of glycaemic excursion

IM and glycemic response-SR & MA (2022)

- 11 RCTs (n = 175 participants), all adults were included.
- Location: 4 countries (Japan, Brazil, Germany, and the Netherlands),
- Population: Healthy, type 2 diabetes, impaired glucose tolerance, and hypertension.

Outcomes	Level of evidence
Oral IM caused an attenuated glycemic response compared with sucrose at 30 min.	Moderate evidence
Oral IM caused an attenuated but more prolonged glycemic response than sucrose and an attenuated insulinemic response.	Low evidence
More benefit of IM for people with type 2 diabetes, impaired glucose tolerance, or hypertension; older people; overweight or obese people; and Asian people.	Low-to-moderate

Xie J et al . Advances in Nutrition. 2022 Oct 2;13(5):1901-13.

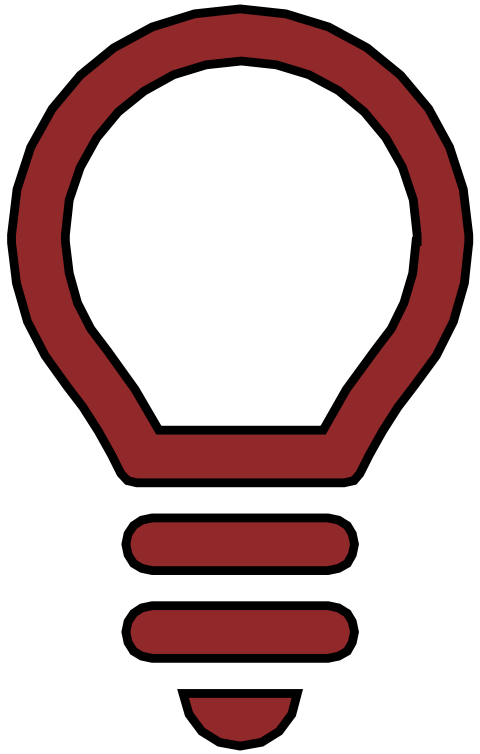


Changes in PP glycemia & insulinemia

- Replacing sucrose with IM is associated with lower and more prolonged glycemic response and an attenuated insulinemic response.
- Patients with T2DM, IGT, or hypertension, older adults, adults with overweight and obesity, and Asians may particularly benefit from the use of IM.
- More RCTs performed using standard mixed meals containing IM to guide its use.

Xie J et al . Advances in Nutrition. 2022 Oct 2;13(5):1901-13.

Mechanistic explorations



COMPOSIÇÃO NUTRICIONAL	
Densidade Calórica (Kcal/ml)	1,0
Proteínas	19%
Carboidratos	47%
Lipídeos	34%
Fonte de Proteínas	Proteína isolada de soja (50%) Proteína do soro do leite (50%)
Fonte de Carboidratos	Amido de tapioca (27%) Lactose (31%) Isomaltulose (38%) Outros (4%)
Fonte de Lipídeos	Óleo de canola (54%) Óleo de girassol (43%) Óleo de peixe (3%)
Fibras	4g/200ml (GOS, dextrina resistente, amido resistente e celulose)
Solúveis	83%
Insolúveis	17%
Relação ω6: ω3	3,7:1
Relação Kcal não protéica/gN	105:1
Outras suplementações	Colina e Mix de carotenóides
Osmolaridade (mOsm/l)	365
Osmolalidade (mOsm/kg de água)	440

Dávila et al. Nutrients. 2019 Jun 28;11(7):1477.

Diabetes specific formula with IM improve PPG response through incretins?

Randomised, double-blind, cross-over study

P: 16 patients with DM2, Brazil

I: ONS-D with IM

C: standard formula

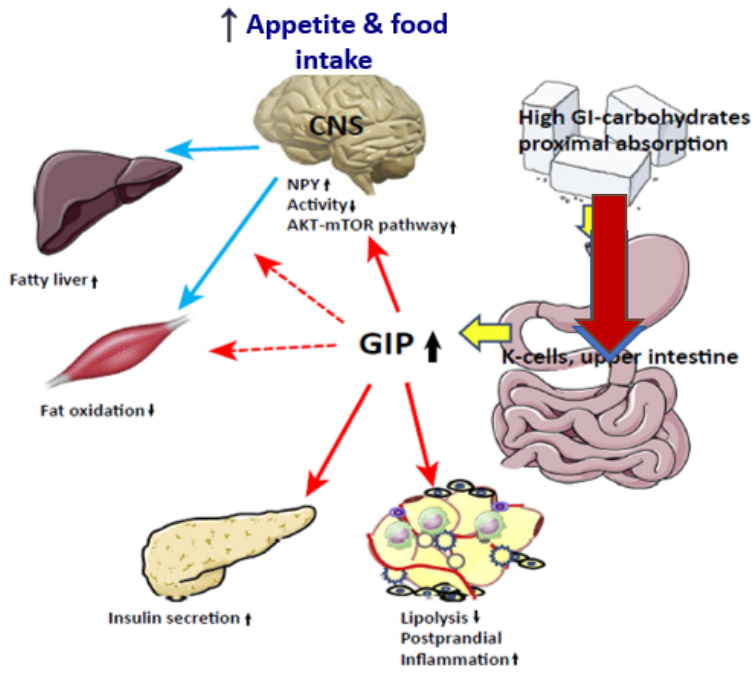
O:

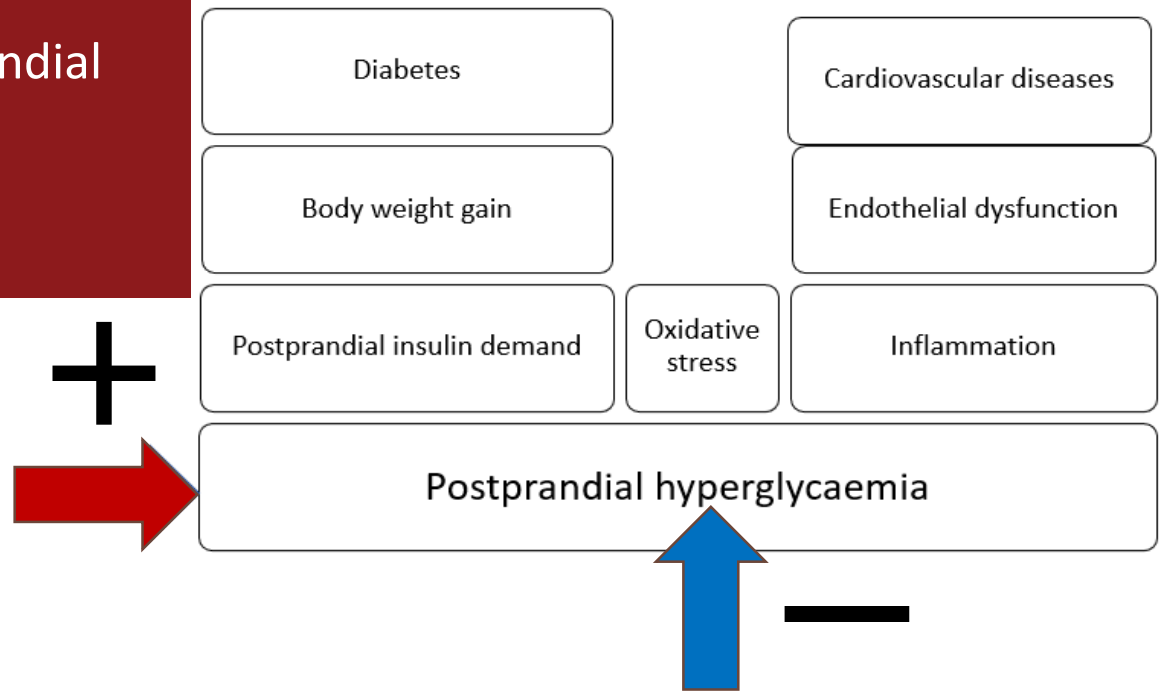
- Lower GI values
- Lower insulin and GIP AUC
- Lower subjective appetite AUC

Gastric inhibitory polypeptide (GIP)

Understanding incretins

- GIP and GLP-1 and their ratio are important determinants of postprandial effects of food
- A lower GIP/GLP-1 may have cardiometabolic benefits





- **GLP-1 secreted by the L-cells, distal part of the small intestine**
  - **Is secreted in response to Low-GI Carbohydrates**

Adapted from: Pfeiffer and Keyhani-Nejad. Trends Endrocrinol. Metab. 2018; 29(5): 296

Gastric inhibitory polypeptide (GIP)
Glucagon-like peptide -1 (GLP-1)

IM and the incretins

Table 1: Human studies suggesting involvement of incretins in low GI postprandial glycaemic response

Author (year)	Country	Participants	Control	Low GI Comparator	Findings (low vs high GI)
Angarita *et. al.* (2019)	Venezuela	T2DM (n= 16)	Std enteral formula	DSF (with isomaltulose and sucromalt)	↓ 3h PP glycaemia ↓ 3h PP INS ↓ 3h PP GIP ↑ 3h GLP-1
Keyhani-Najad *et. al* (2016)	Germany	T2DM (n= 10)	Sucrose solution	Isomaltulose solution	↓ 3h PP glycaemia ↓ 3h PP INS ↓ 3h PP GIP ↑ 3h GLP-1
Motallib *et. al* (2016)	USA	T2DM (n=22)	Oatmeal	DSF with isomaltulose and sucromalt (GI difference not discernible)	↓ 4h PP glycaemia = 4h PP INS ↑ 4h GLP-1
Sakuma *et. al* (2009)	Japan	IGT (n=2) & T2DM (n=7)	dextrin-based liquid formula	isomaltulose-based liquid formula	↓ 3h PP glycaemia ↓ 3h PP INS
Gaps:	1. Effects predominantly relies on presence of low GI sugar (Isomaltulose) and drinks/formula 2. Generalisability to real foods is unknown. 3. GIP has scant data 4. No comparison of effect between healthy and prediabetes possible with existing data				
Abbreviations	PP- postprandial; INS-insulin, GIP- Glucose-dependent Insulinotropic Polypeptide, GLP-1- Glucagon-like peptide-1; DSF: Diabetes Specific Formula				

IM and the incretins

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Keyhani-Na *et. al* (201					
Motallib *et* (2016)				discernible)	↑ 4h GLP-1
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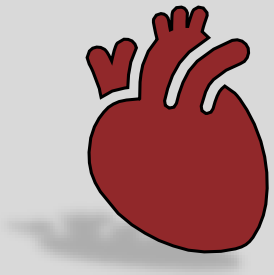
Abbreviations	PP- postprandial; INS-insulin, GIP- Glucose-dependent Insulinotropic Polypeptide, GLP-1- Glucagon-like peptide-1; DSF: Diabetes Specific Formula				

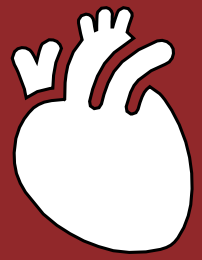
IM may lower GIP/ GLP-1 ratio in comparison to higher GI alternatives

This can have cardiometabolic advantages above and beyond the management of postprandial glycaemia



Isomaltulose & Novel Cardiovascular Outcomes

Novel cardiovascular outcomes

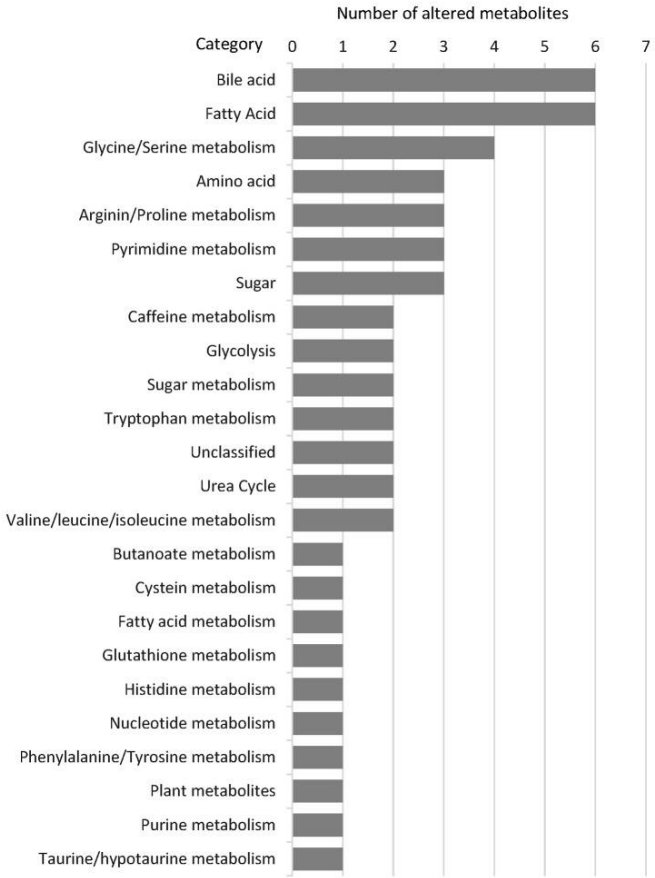


Reference	Country	Study design	Population	Control	Outcomes
Kawaguchi et al (2018)	Japan	Randomised SB Cross-Over	5 male patients with NAFLD	Sucrose	Bile and fatty acid metabolism
Kobayashi et al (2021)	Japan	Cross-Over Study	10 healthy middle-aged and older adult	Sucrose	Brachial wave and pulse wave velocity
de Groot E et al (2020)	Ireland	Randomised DB Cross-Over	80 overweight mildly hypertensive adults	Sucrose	FMD

IM better than control
No sig effect
Control better than IM

IM in patients with non-alcoholic fatty liver disease: A metabolomic analysis.

- Male patients with NAFLD (n=5) consumed 20 g IM or sucrose.
- Outcomes evaluated
  - Changes in insulin resistance by alterations of serum C-peptide immunoreactivity (CPR)
  - Metabolomic analysis from baseline to 15 min after the administration

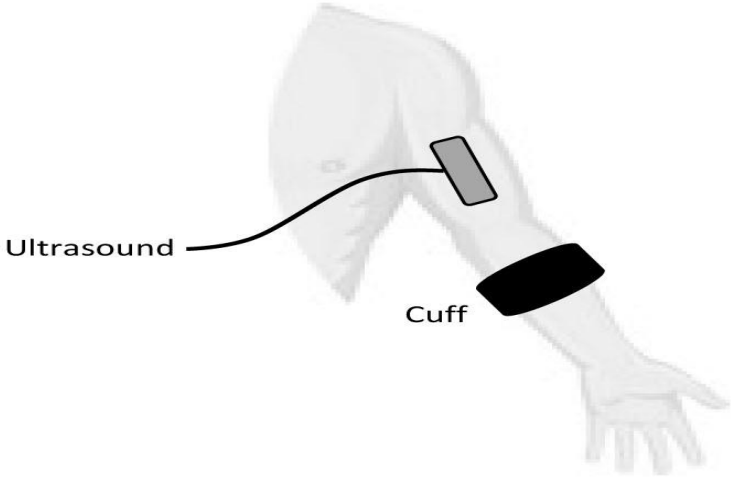


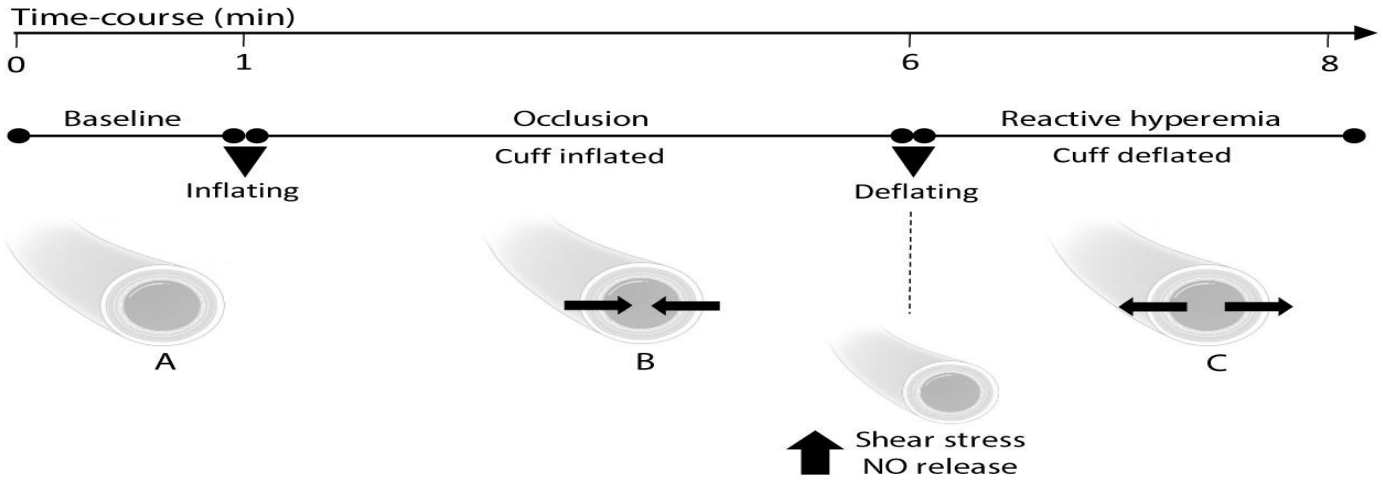
Findings

- No significant difference in blood glucose changes.
- IM significantly ↓ CPR level.
- Significant alterations in 52 metabolites
- IM particularly affects **taurodeoxycholic acid** (↑ 12.5-fold), and **arachidonic acid** (↓ 0.01-fold).
- Demonstrated that IM **improved insulin resistance** in NAFLD patients.
- May be **modulated through alterations of bile and fatty acid metabolisms**.

Kawaguchi et al (2018)

Understanding Flow Mediated Dilatation (FMD)





FMD measures the release of NO by the endothelium due to a transient flow stimulus.

Impaired FMD is an early & potentially reversible, manifestation of vascular disease and may represent an integrated measure of the impact of various insults to the endothelium.

Yeboah et al . Circulation. 2009 Aug 11;120(6):502-9.

FMD study with Palatinose™

Title: "Efficacy of Isomaltulose Compared to Sucrose in Modulating Endothelial Function in Overweight Adults"

Study aim: To investigate acute effects of IM vs SUC on endothelium-dependent vasodilation in OW.

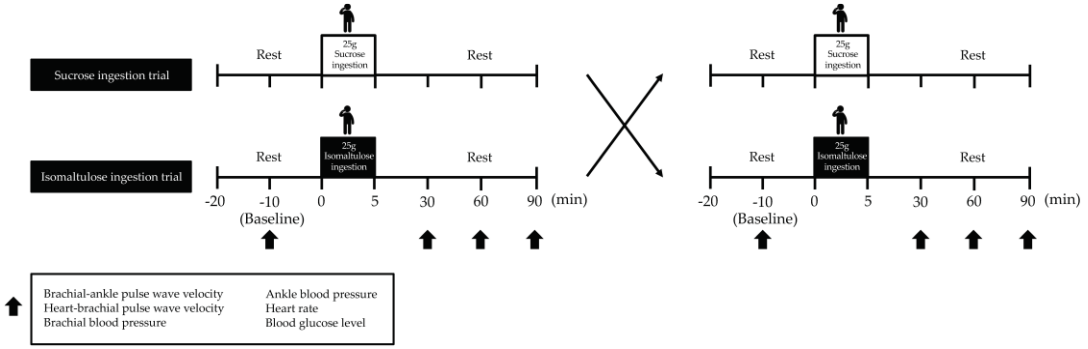
Design: Acute RCT, double-blind, cross-over
Subjects: 80 ow/ob subjects
Dosage: 50g IM vs SUC
Outcomes: FMD (= EFSA accepted),Glucose, Inuslin

Findings: *'Low-glycemic IM **attenuates postprandial decline in endothelial function** if compared to sucrose. This **was particularly seen in individuals with impaired glucose tolerance**. ' Therefore, IM **may promote cardiovascular health**.'*

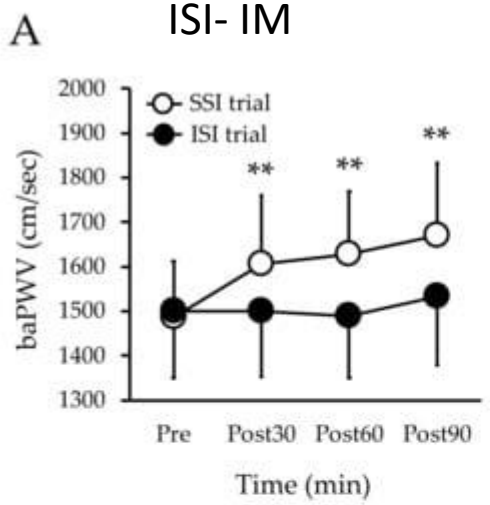
de Groot et al. Nutrients. 2020 Jan 3;12(1):141.

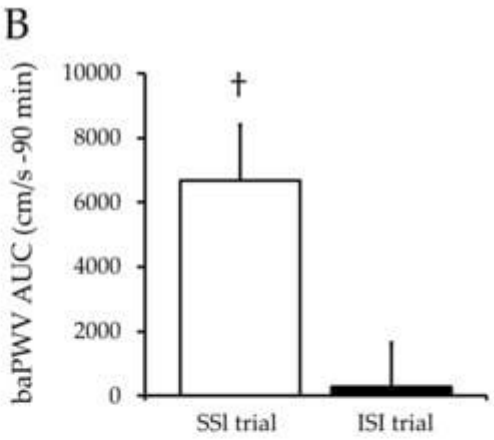
IM and arterial stiffness

10 healthy, normotensive middle-aged and older adults



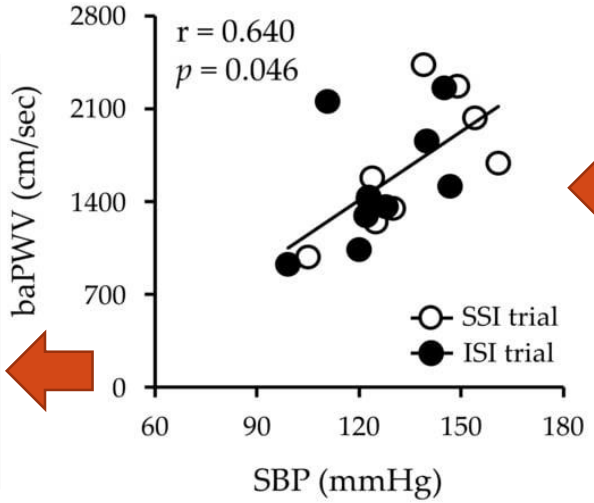
SSI- sucrose
ISI- IM

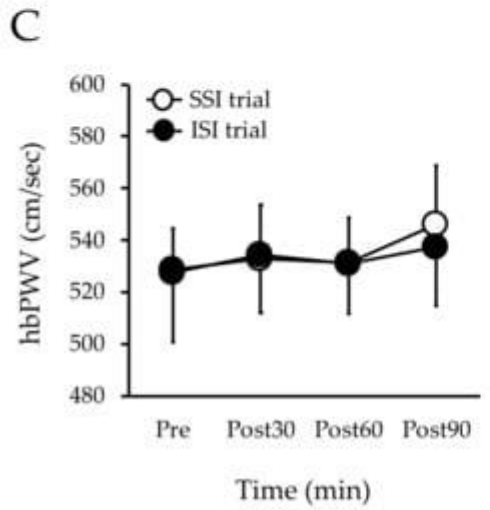


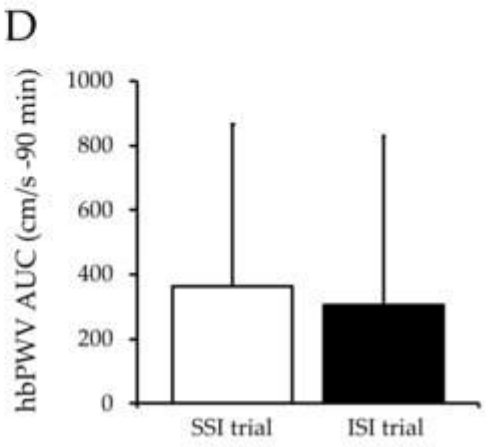


Conclusion:

- IM inhibits an acute increase in arterial stiffness.
- May have significant clinical/dietary implications for middle-aged and elderly patients.







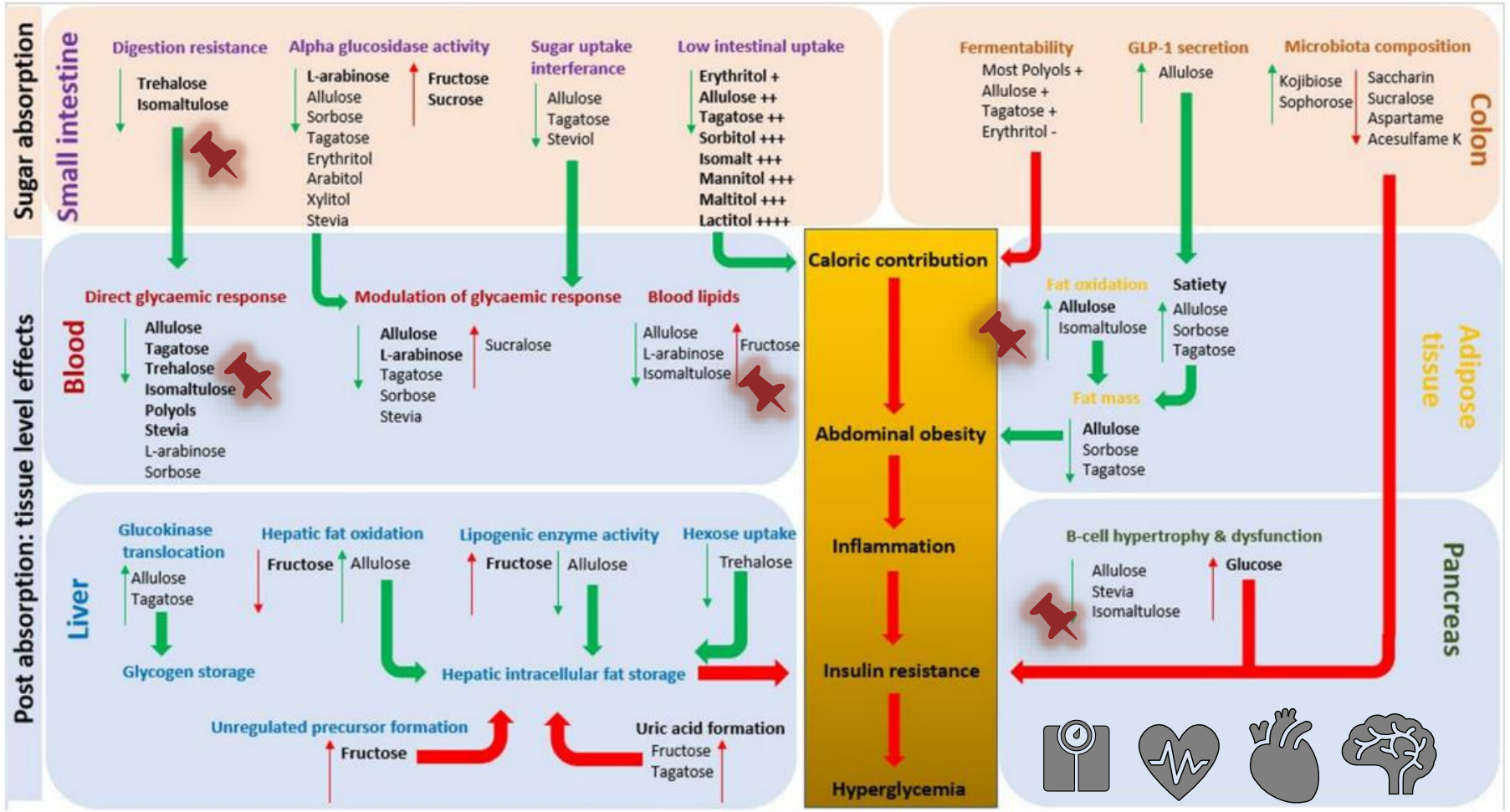
Kobayashi et al . Nutrients. 2021 Dec 15;13(12):4493.

Summary of existing evidence

Timeframe	Healthy	Obese/overweight	T2DM/Pre-DM
Acute	Reduced PPG Improved FMD	Reduced PPG Improved FMD	Reduced PPG
Longer-term	Reduced HOMA-IR	Reduced body weight	Reduced HOMA-IR

Ahmed et al. Nutrition Reviews. 2022 Feb;80(2):255-70.

Metabolic actions of IM in humans: SR



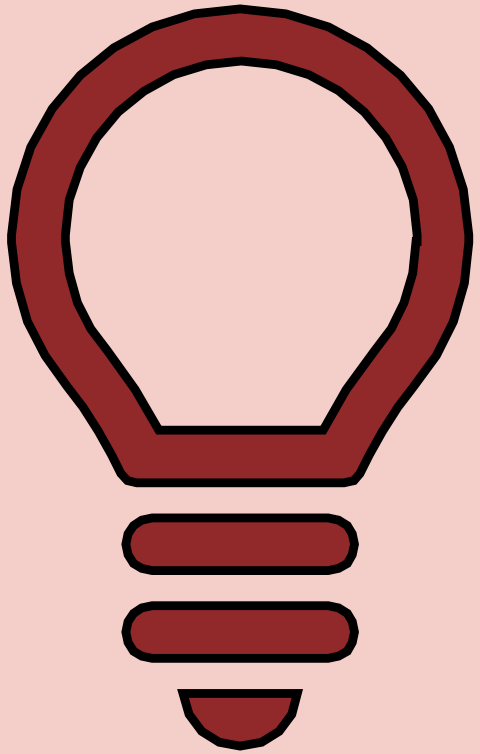
Several beneficial effects of IM on metabolism noted

- Slower absorption
- Reduce glycemic response
- Improved fat oxidation
- B cell protection

- Scope for further research

Van Laar et al . Critical Reviews in Food Science and Nutrition. 2021 Mar 9;61(5):713-41.

Futuristic Innovations

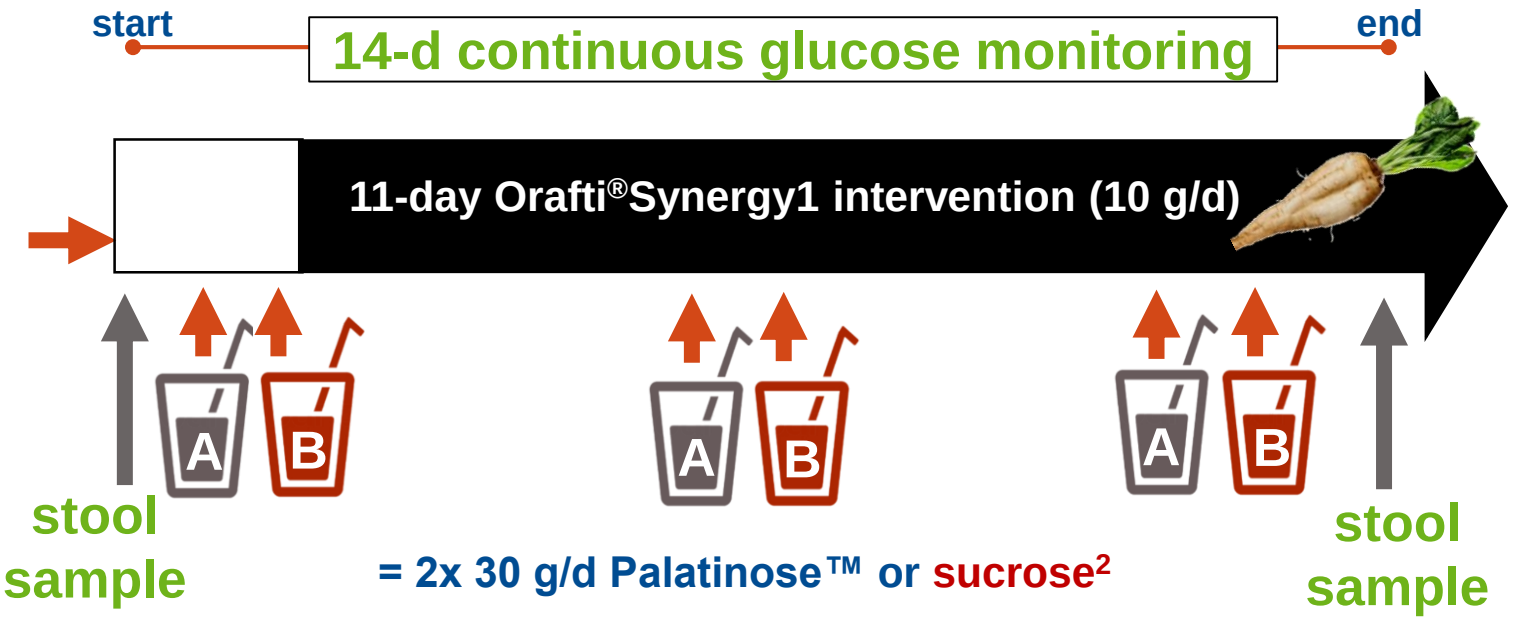


Citizen science approach with IM and Inulin-

What happens in real-life?

'Citizen Science' is "*the practice of citizens performing science and of scientists working together with citizens*"[1]

N= 117



Outcome measures:

- 14-d continuous glucose response (CGMS)
- Gut microbiota (16S rRNA sequencing)
- Food intake (14-d food diary)

Kordowski et al. Frontiers in Nutrition. 2022;9.

Used Palatinose™ and Orafti®Synergy1

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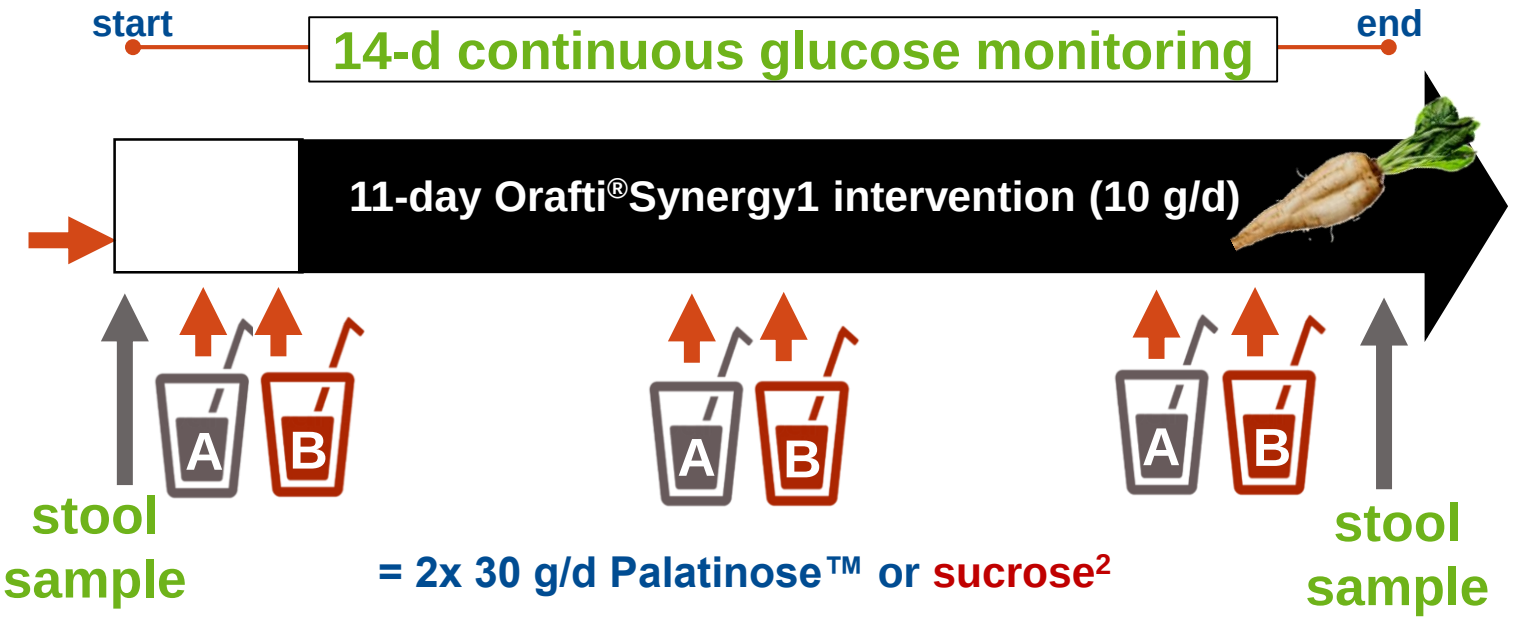

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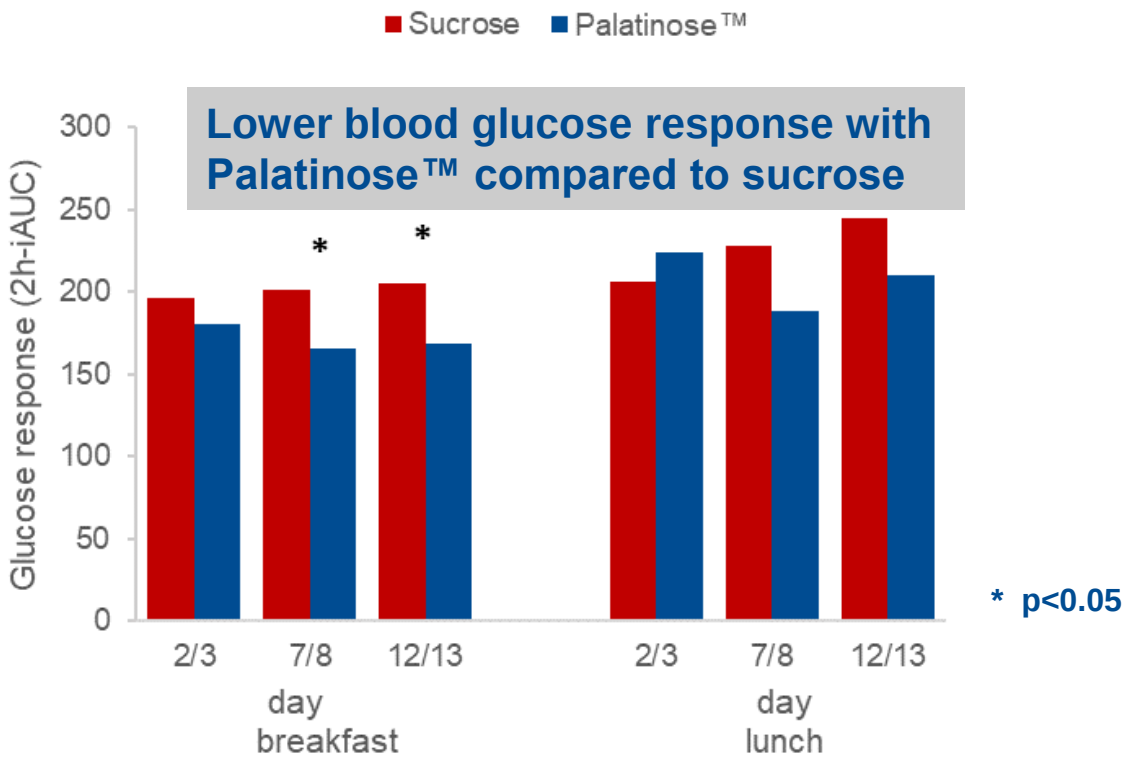
Kordowski et al. Frontiers in Nutrition. 2022;9.

Used Palatinose™ and Orafti®Synergy1

Citizen science approach with Isomaltulose and Inulin

Results from in free-living participants



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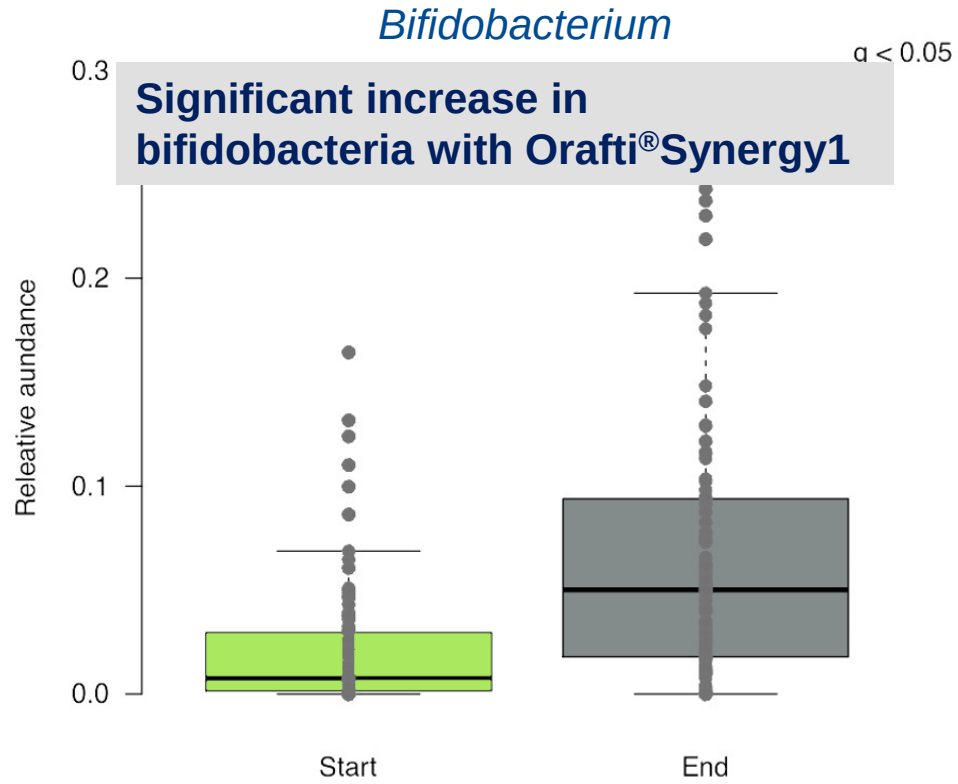
Kordowski et al. Frontiers in Nutrition. 2022;9.



Kordowski et al. Frontiers in Nutrition. 2022;9.

IM + Inulin: Potential for personalisation?

- Confirmed beneficial effetc of IM (Palatinose) vs sucrose in a real-life
  - Lower postprandial blood glucose response
  - More balanced blood glucose profile throughout the day (less glucose oscillation)
  - Slow release and sustained glucose supply
- The decrease in glycaemic variability improved significantly with 10 g of oligofructose enriched inulin (Orafti®Synergy1).→ synergistic effects?
- Inulin significantly increased bifidobacteria.→ explains synergy

Kordowski et al. Frontiers in Nutrition. 2022;9.

IM + Inulin: Potential for personalisation?

- Though everyone responded with lower PPG in response to IM vs sucrose, 72% were good responders
- Gut microbiota composition determined level of beneficial effect to IM.
- Higher Firmicutes:Bacteroidetes ratio → better effects
- Scope for personalisation using functional food ingredients

Kordowski et al. Frontiers in Nutrition. 2022;9.

Food applications of Isomaltulose

Physiological properties of nutritive sweeteners.

Sugars	Glycemic classification	Energy content(kcal/g)	Relative sweetness tosucrose (100)	Relative glycaemic response (RGR)	Relative insulin response (RIR)	Status	For diabetic patients use
Monosaccharides							
Glucose	High	4	70-80	100	100	Food	No
Fructose	Very low	4	120	19	9	Food	No
D-tagatose	Very low	1.5	92	3	3	Novel	Yes
Disaccharides							
Isomaltulose	**Very low**	**4**	**40-50**	**32**	**27**	**Novel**	**Yes**
Lactose	Low	4	30-50	46	-	Food	No
Maltose	High	4	40-50	105	-	Food	No
Sucrose	**Intermediate**	**4**	**100**	**68**	**45**	**Food**	**No**
Trehalose	High	4	45	72	51	Novel	Yes

Sokołowska et al. Critical reviews in food science and nutrition. 2022 Jul 18;62(21):5679-704.

List of patent applications for isomaltulose

Application	Patent Number (publication date)
Food Additive/ingredient	SG11202000810T(A) (2020-02-27); PL1677618(T3) (2011-10-31); PL1858348(T3) (2016-08-31); DE102011012205(A1) (2012-08-02); ZA200501009(B) (2006-10-25); DE102008037185(A1) (2009-03-12); WO9508926(A1) (1995-04-06); WO2006119991(A1) (2006-11-16)
Quality improvement	PL2931057(T3) (2020-02-28); NZ581366(A) (2012-06-29); ZA200506219(B) (2006-12-27); US2006096587 (A1) (2006-05-11); US20060096587(A1) (2006-05-11)
Nutritional supplement/Functional food	US2010004194(A1) (2010-01-07); PL2592950(T3) (2018-09-28); US2011009358(A1) (2011-01-13); EP2272521(A1) (2011-01-12);US2006188627(A1) (2006-08-24)
Flavor modification/enhancement	EA200870429(A1) (2009-04-28); US2008175974(A1) (2008-07-24); WO2004008870(A1) (2004-01-29); DE102008050591(A1) (2010-04-15)

In 2006, FDA approved IM (content ≥ 98%) as GRAS (No. 184).
In 2017, FDA approved dried IM syrup (content ≥ 80%) as GRAS (No. 681),
Approved for use as a sweetener in foods and beverages at the same use levels as sucrose.

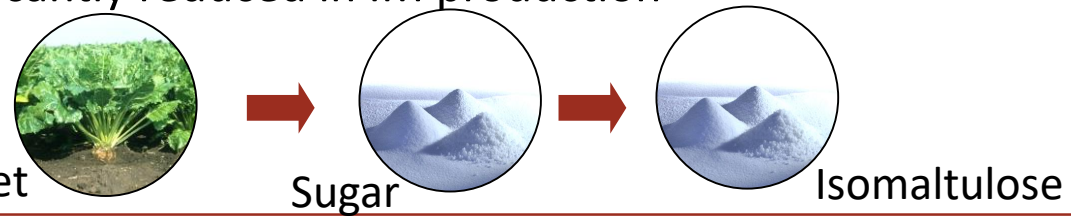
Sokołowska et al. Critical reviews in food science and nutrition. 2022 Jul 18;62(21):5679-704.
Tian et al. Applied Microbiology and Biotechnology. 2019 Nov;103:8677-87.

Factors facilitating translation of benefits

Production costs

- Economic barrier has been significantly reduced in IM production

Produced via **non-GMO enzymatic** rearrangement of sucrose



Interest of potential customers

- Most similar taste achievable in three food matrices (black tea, chocolate milk, and natural yogurt) among 8 sweeteners tested

Sokołowska et al. Critical reviews in food science and nutrition. 2022 Jul 18;62(21):5679-704.

Tan et al . Journal of Food Science. 2020 Feb;85(2):486-92.

Food applications of IM

Isomaltulose containing foods in Malaysia

- ✓ Child growing-up formula
- ✓ Oral nutritional supplements
- ✓ Muscle-building supplements
- ✓ Health supplements
- ✓ Sports supplements

Tian Y, Deng Y, Zhang W, Mu W. Applied Microbiology and Biotechnology. 2019 Nov;103:8677-87.

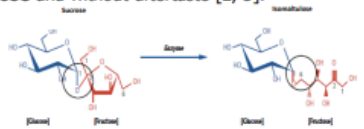
Development and Sensory Evaluation of Egg Custard Pudding Using Isomaltulose

Chang CY[1], Tan SS[1], Shyam S[1], Chong MHZ[1]
[1]Division of Nutrition and Dietetics, School of Health Sciences, International Medical University


Undergraduate

INTRODUCTION

- High consumption of sugar → extra calories → positive energy balance and weight gain → obesity, a risk factor of diabetes mellitus [1].
- High demand for sugar intake in Malaysia raise concern on substitution of sugar.
- Isomaltulose (IM):
  - Potential substitute to sucrose, has **low glycaemic index** (32) and **non-cariogenic properties** [2].
  - Has stable α-1,6 glycosidic linkage between glucose and fructose [2].
  - Has similar taste, but **half sweetening power to sucrose** and without aftertaste [2, 3].



- Substitution of sugar may cause difference in sweetness, appearance, aroma, taste and texture [4].
- Sensory properties are crucial factors for consumer's acceptability towards a product [5].
- Sensory evaluation is important to measure the consumer perception of senses towards the quality of products [6].
- Limited evidence on sensory attributes and acceptability of IM in chilled desserts.
- Egg custard pudding with high content of sugar and simple ingredients was chosen to be the test product.

OBJECTIVE

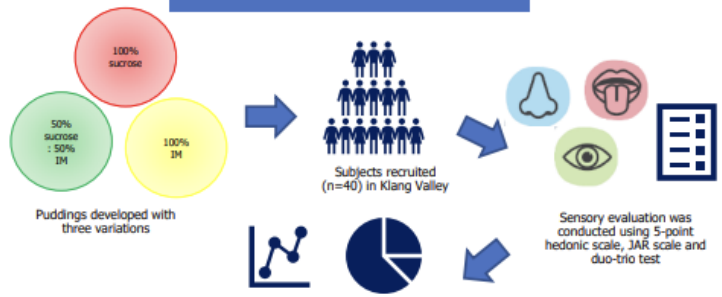
To determine the sensory attributes and overall acceptability of egg custard pudding made with isomaltulose.

SUBJECTS

Inclusion Criteria:
- Chinese Malaysian adults
- Aged 18 to 50 years

Exclusion Criteria:
- Heavy smokers (≥25 cigarettes daily)
- Heavy alcohol consumers (≥8 drinks a week)
- Pregnant and lactating women
- Adults with long-term medication

METHODOLOGY



RESULTS

- A total of 40 subjects in which 23 males and 17 females completed the study.
- Mean age of subjects: 23.2±5.5 years.

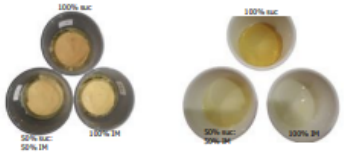


Image 1 Appearance of egg custard pudding (left) and caramel (right) made from three variations of sugars.

Table 1 Comparison of the sensory attributes across the three variations of pudding.

	Pudding variations	Mean±SD	p value
Appearance	100% suc	3.78±0.97*	0.001
	100% IM	3.30±0.99**	
	50% suc: 50% IM	3.95±0.75*	
Aroma	100% suc	3.43±0.98	0.768
	100% IM	3.45±0.88	
	50% suc: 50% IM	3.53±0.85	
Taste	100% suc	3.65±1.05	0.136
	100% IM	4.03±0.86	
	50% suc: 50% IM	3.68±0.97	
Texture	100% suc	3.95±0.88	0.502
	100% IM	3.73±0.99	
	50% suc: 50% IM	3.85±0.92	
Overall acceptability	100% suc	3.65±0.95	0.549
	100% IM	3.85±0.86	
	50% suc: 50% IM	3.75±0.87	
Sweetness	100% suc	4.45±0.78*[1]	<0.001

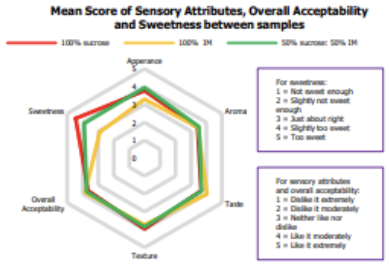


Figure 1 Radar chart shows the mean scores of sensory attributes, overall acceptability and sweetness between the three samples.

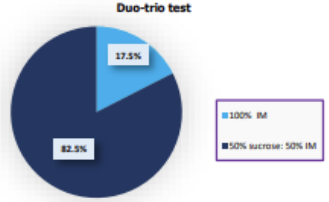


Figure 2 Pie chart illustrates the proportion of people choosing

DISCUSSION

- 100% IM pudding had the lowest rating in **appearance**: IM has lower melting point and higher stability of glycosidic bond, exhibits less caramelisation [7].
- No significant difference in **aroma and taste**, coherent with the study on marshmallow [8].
- Aroma of egg custard pudding may be developed from caramelisation of sugar or from the milk, thus a more comprehensive descriptive test needs to be undertaken to determine the specific contributors.
- Most of the subjects preferred the taste of 100% IM pudding: IM exhibited less sweetness that possibly influence the overall taste of the pudding.
- **Texture** was not significantly different between groups, similar to cookies substituted with xylitol [9].
- Mushy texture was found in 100% IM pudding: IM has low hygroscopic feature with reduced water-holding capacity to retain moisture [2].
- **Overall acceptability**: Half and full IM replacement in pudding were better accepted than the 100% sucrose pudding, similar results found in studies on marshmallow [8] and lemon marmalade [10].
- **Sweetness**: 100% IM pudding obtained a mean score nearest to just about right, may due to lower sweetness preference in Chinese population [11].
- In **duo-trio test**, pudding samples made with sucrose and IM were perceptibly different: Possibly linked to the significant differences in terms of appearance and sweetness obtained in this study.

CONCLUSION

- Positive results in aroma, taste, texture and overall acceptability between three variations of egg custard puddings.
- Egg custard pudding made with 100% IM was the most accepted by the subjects, with highest score obtained in taste, while sweetness was nearest to just about right.

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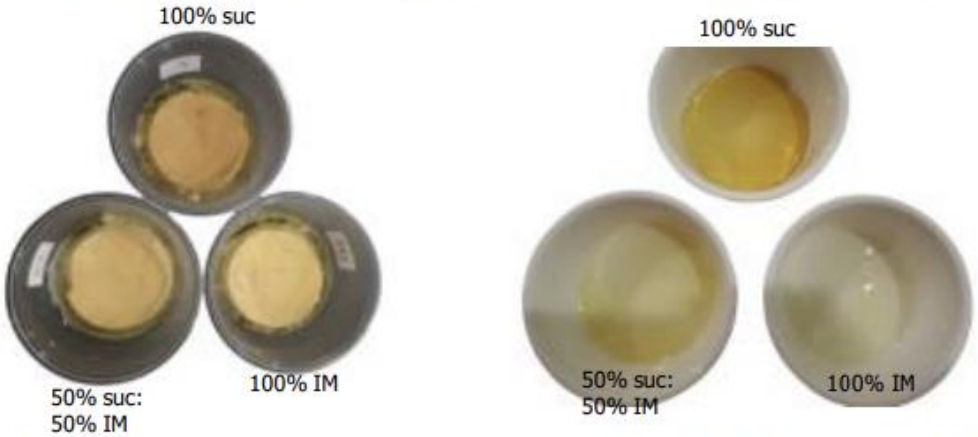

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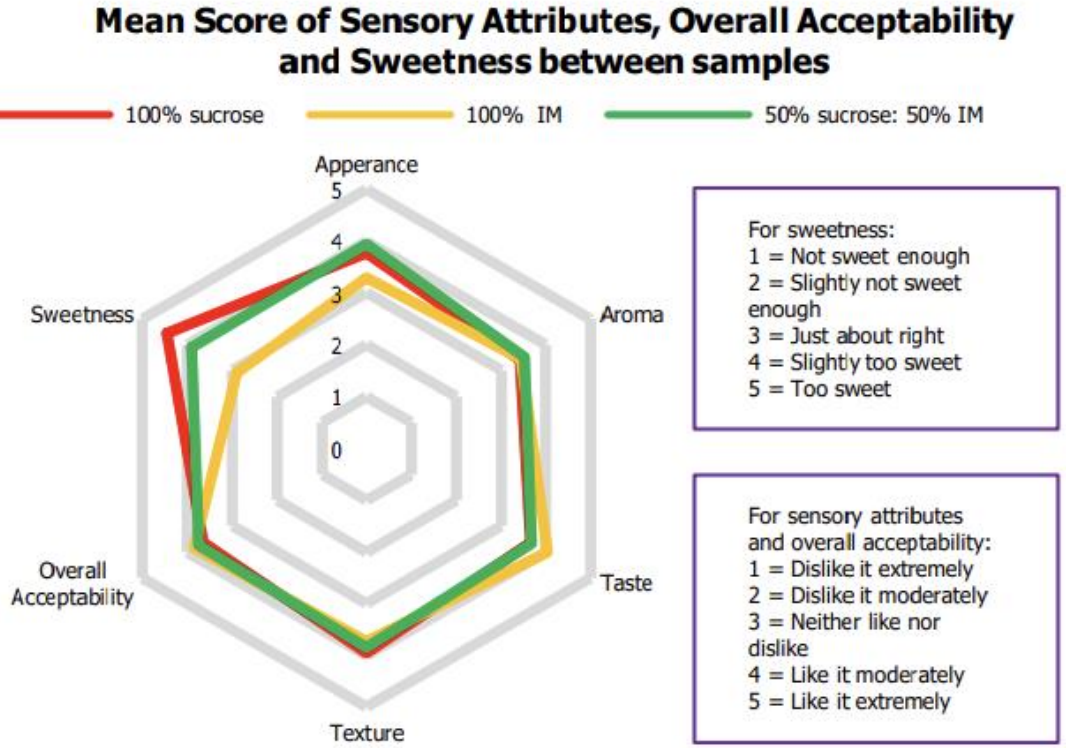

Figure 1 Radar chart shows the mean scores of sensory attributes, overall acceptability and sweetness between the three samples.

Take Home Messages

- IM is a promising alternative for body weight and glycaemic management
- Mechanistic evidence for it effects is accruing
- IM provides potential for food innovation
- Long term trials and research into personalisation may be useful

Acknowledgement

Prof. Jordi Salas-Salvadó, MD, PhD

Distinguished Professor of Nutrition and ICREA-Acadèmia Researcher at Universitat Rovira i Virgili.

References available on request

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