

## **“Glycaemic Index of Foods: “Challenges for the Food Industry & Human Health”**

**Professor Jeya Henry**



I thank the British Society of Baking for inviting me this morning and particularly to Paul Morrow for this kind invitation. I think I am right in saying we are in the midst of a global food revolution: - In fact at no time in human history have we had on the one hand an enormous abundance of food, and on the other a near obsession about what we eat. So my theme this morning, is to explore with you the Glycaemic Index as one aspect of nutrition and food technology, along with articulating what are the challenges and opportunities for the Baking industry.

Let's start by asking ourselves what is this concept called "Glycaemic Index." My first slide shows you very eloquently and captures very visually what the Glycaemic Index is all about. Here we have seven different carbohydrates sources, glucose, kidney beans, potatoes, lentils, oatmeal, and bread exactly the same amount of carbohydrates, 50 grams, and you will notice two very dramatic profiles. The first is that when you feed 50 grams of glucose there is a very large peak of the blood glucose response followed by a dramatic fall compared to foods like oatmeal and kidney beans where the peak is much lower than the glucose and also the area under the curve is much smaller. Two points to remember is that Glycaemic Index is all about how quickly blood glucose -and secondly is what is the area under the curve. You will appreciate the area under the curve of the glucose is much larger than the area under the curve of oatmeal, so oatmeal and lentils will be called low GI foods because they increase the glucose response much more modestly compared to foods such as rice, where the Glycaemic response is much larger. The Glycaemic Index is simply a method of ranking foods on a scale according to the extent of which foods raise blood glucose. Foods which breakdown quickly during digestion have a high GI value and conversely carbohydrate foods that are broken down slowly will be there called a low GI food.

Now rather paradoxically the Glycaemic Index concept is only about 25 years old, it was only conceived in 1981 by two British scientists working in Canada because to measure the Glycaemic Index you need to measure blood glucose values rather non invasively. It was only during the past 20 years that we can measure rapidly blood glucose values using either finger prick or venous samples and therefore the whole area of Glycaemic Index is quite new in nutrition. To put it in context by 1919 we knew that proteins were different in terms of quality and quantity. By 1932 we knew that fats were different in quality and quantity. So in terms of the three major nutrients, proteins, fats and carbohydrates, the realization that carbohydrates were different in terms of glucose and blood glucose response is new. Hence our journey into Glycaemic index is nothing but the blink of an eye in terms of nutritional history.

**So how is GI calculated? It's an incremental area under the curve of the test food divided by the corresponding amount of carbohydrate either as white bread or glucose as the denominator. So it's basically a ratio measurement of two areas, one for the food, one for the carbohydrate. You take a small finger prick and you measure the glucose levels after the ingestion of 50 grams of glucose over a two hour period from which you can draw the area under the curve which I talked about. This is done three times on each subject followed by one day gap and then of course you feed the test food that we talked about, maybe its bread, or pasta or whatever on the fourth day and therefore you can appreciate how time consuming both in terms of space and occupation.**

**So how is GI tested in Oxford Brooke? We follow a protocol set up by the FAO and the WHO and many of you know that much of the work has been really promoted and supported by Tesco. Tesco as you know have played a pivotal role in GI testing and GI propagation in this country and in Europe, and at the last count we had tested for Tesco about 300 foods.**

**So for those who want to know a little bit more about our work there are two papers that were published a few months ago in the British Journal of Nutrition (2005). The first will provide GI values of about 170 different foods of British origin. The second on the GI of potato varieties.**

What about GI classification? This is quite a contentious area because Prof Jenny Brand-Miller from Australia made this classification more on intuition than rigorous science. She proposed that foods that have a value below 55 low GI because she found that most lentils and legumes had a value below 55 and she found that most breads had a value above 70, so she said I'm going to call it high GI. I'm going to say quite emphatically these classifications were based on pragmatic common sense and not on biology. As you can see, the difference between Low and High GI is quite modest. Values between 55-70 have only 15 units of difference, what I'm trying to say to you is that the distinction between a low GI food and a high GI food is much more real than one between low and medium and medium and high GI.

In fact one of the global companies that have taken a great interest in the Glycaemic Index is the Danone Group in France. If you have been to France and consumed LU biscuits, they were the first to use the GI concept, not from the concept that we have talked about, but they said to the consumer that low GI foods gave a long lasting blood glucose response. These biscuits were a food we could eat for breakfast and therefore have a slower and a longer release of blood glucose.

We have in the past two years, in collaboration with a whole range of food companies across Europe, North America and Britain helped them both to develop and test GI foods and I'm just going to show you three examples of foods that are central to your industry. A bread made by Warburtons called "All in One" which is a white bread. Remarkably Warburtons have been one of the first companies of international reputation to go into a white bread that is low GI. The second bread is made by Paul Morrow's company in Bicester which is a Multiseed bread and as you know marketed extensively by Sainsburys. We have used these two breads for an extensive experimental study which I will come to in a minute, but just to point out to the large and medium sized companies that developing low GI foods is not as challenging as it may sound. If you currently have a medium or high GI food, can one bring down the Glycaemic index? The Glycaemic Index is profoundly altered by a whole range of factors; these include the amount and presence of fructose, glucose and galactose and the presence of acidulants.

Amylose and Amylopectin are the two major starch fractions, and amylose is a long chain molecule while amylopectin is a branched chain molecule. The more amylose you have in your food system, the lower the Glycaemic Index. By changing the process conditions, by changing the presence of certain food components, you can actually alter the GI of foods. Most importantly without changing its taste, texture and palatability.

Now why is it that most breads are conventionally medium or high GI? This is partly because the starch is gelatinized and therefore is ready for the enzyme amylase action in the gut.

High amylose starch is something that is much more resistant and therefore does not get gelatinized easily. Therefore if you have a food system that has got a high amylose content it will always tend to have a lower GI value.

One of the interesting things is that we know from the literature and our own studies that most pulses have a very low GI value. You can see from this microscopic cross section that the starch molecules are completely surrounded by a very thick cell wall and the cell wall acts as a kind of gatekeeper in not allowing the amylase enzymes to break down the starch and therefore the starch molecule is intact and the Glycaemic is quite low. Why am I showing this to you? Because you can them quite cleverly use the technique of protecting your starch molecules by using certain types of food ingredients to preserve and conserve the starch molecules from amylase attack and therefore reduce the Glycaemic response.

I'm going to stop now and ask the question, what's the fuss? What's the buzz? Why are we so keen about the Glycaemic Index? Why are we doing it? What is the nature of Glycaemic index in terms of human health and well being?

As many of you know the three major chronic diseases inflicted on the UK population are obesity, diabetes, cardiovascular disease and added here of course are cancer and carcinoma, and the question we've got to ask is how does a low GI diet affect these three major pandemics of national concern. Some of you will have seen this little boy from mainland China. This boy is a little under 4 years old and weighs a little under 40 kgs. He should be weighing only 20 kgs, so the question is how does a child of 4 years become so grossly overweight and obese, it really must be because he's eaten more than he can expend or he is expending less energy than he's eaten. So that's child No 1.

My friend No 2 is 18 years old and weighs 43 stones. So here are two dynamic examples of the nature of the problem that we are talking about.

Now if you look at the global European nature of obesity, it's quite alarming. You have countries like Yugoslavia where nearly 40% of women are obese. So gentlemen don't take your spouses to Yugoslavia, take them to Switzerland!! And the second question I have is a more fundamental one, why is it that women of every nation, except Hungary, hence their name, are more likely to be overweight than men. And that's a very interesting observation – why are women more susceptible to overweight and obesity?

Now if you then look at the global estimates of diabetes, it's absolutely frightening. Asia, that's only India and China in 1997 had 66 million diabetics, and I'm told by 2010, not very far away just down the road, India alone will have nearly 55 million people with diabetes – diagnosed diabetes, not pre-diabetes, that's the whole of the UK population!

So the question is, ladies and gentlemen what do we do as a food industry to reposition opportunities that are going to come up in countries beyond Europe? I think diabetic control using food is going to be the key challenge for our industry and our society. And if you look at Europe again, not as dramatic but certainly increasing.

If you then look at the presence of diabetes in Europe you find that Finland has got about 7% of the population as diabetics.

In the UK you have quite a modest value but this modest value of 2.5% slightly camouflages a very serious dilemma, which is that south Asians living in Britain have a five fold increase of risk of diabetes than the Caucasian population. In other words, put another way, after the age of 40, one in four people of south Asian origin living in Britain have either pre-diabetes or diabetes, so therefore there's a huge caucus of concern within our nation and therefore this should really be 4/5% in my interpretation because of the larger skew among the south Asian population.

So what is the role of a low GI diet in trying to contain or combat diabetes. As many of you know diabetes is a runaway disease of poor glucose control in the blood and the theory that has been put by Augustine is that a high GI diet will obviously increase the blood glucose, as you saw in my first slide, which will increase your insulin response consistently which in turn will cause insulin receptors to be down regulated and therefore you have insulin insufficiency. A huge flux of blood glucose

consistently leads to huge flux of insulin which in turn will actually suppress your pancreas to produce more and more insulin and therefore you become diabetic.

So I have looked at the literature and found there are two papers where Jenny Brand- Miller has looked at the use of a low GI diet to contain or control diabetics. And as you can see in this slide published in Diabetics Care, looked at about 14 studies both with Type 1 and Type 2 diabetes. She found that within a 10 week duration HbA1C which is a measure of long term blood glucose, was dramatically reduced in people that were on a low GI diet. The reduction in HbA1C recorded using a low GI Diet was similar to that observed in patients taking tablets for the disease.

So in my analysis I would be very comfortable to say that if you are a diabetic or a pre-diabetic, going on a low GI diet will certainly contain and control your blood glucose level as much as, or equal to a drug related control, and the challenge is to see if we add a low GI diet to your tablets and therefore increases its efficiency. In Countries like India and China, how on earth are we going to give 50 million people tablets for diabetes? Impossible. The clear answer should be that we provide a food that is both tasty, palatable, delectable, but above all also is low GI, or medium GI which will also bring down the glucose flux in a way that is opportunistic and challenging.

Now I want to look at some experiments we have been doing in our laboratory and here we have a machine that's been in the market for about three years from North American which is a continuous blood glucose monitor that looks almost the size of a mobile telephone. The probe is fitted sub-cutaneously and it can continuously monitor your blood glucose. For the first time we can see what happens to blood glucose when we feed you different types of foods. It's a very fascinating machine. So these are based on ten subjects where all we have done is to give them breakfast, lunch, supper and snacks where all foods provided were either low GI or high GI. The "All in One" and the Bakels Multiseed bread were used as low GI breads and standard white bread as high GI .

To our amazement and delight we found that, that on a low GI diet the blood glucose level is consistently lower, these are changes in blood glucose level, compared to the high GI diet. I think you would agree with that, this is the first time that anybody has shown what happens to your glucose flux over a 24 hour period on simply being on a low GI or high GI diet.

Now the question would be, what would you expect it to be if you were a diabetic, and that's what we are trying to do, because these are normal subjects and in a diabetic you would expect to see the separation to be much greater.

Let me quickly move on to energy balance and obesity. Obesity is the outcome of being in positive energy balance over a particularly short or long period of time. You need to be only off by about 60/70 calories per day to become obese over a couple of years. If you can actually reduce a subject's food intake by about 80/100 calories per day, or increase energy expenditure by 80/100 calories per day, your risk of obesity is much less logically.

So the question is what does the Glycaemic index do in terms of your weight regulation. The study we conducted in primary school children will be presented now.

We went to a Primary school in Oxford and gave the children a low GI breakfast, a high GI breakfast or a low GI with some sucrose. Obviously the addition of sucrose was quite important because these children found it quite hard to eat foods that normally taste like cardboard! Each child acted as his own control where they either had three times the low GI breakfast, All in One, Swiss type, not Swiss type breakfast, or porridge which was made from oats, all bran or Bergen bread. We then exposed these children to an ad libitum lunch so they could choose what they wanted, they had six different rounds of sandwiches, fillings of different types, pizzas, cakes, cookies, things that children like to eat. To our amazement what we found, despite the children's ad libitum access to food, the children on the low GI breakfast were consistently eating 150 calories less than children given the high GI breakfast. So in other words there was a metabolic containment of these children's appetite in a way that they were selecting less calories when exposed to ad libitum foods.

When this paper was published, not surprisingly we had a lot of global interest because you're saying for the first time the type of breakfast you give will have a spatial and temporal impact on your lunch meal event. Now quite rightly when the paper was published it generated some criticism. An important question was: do those children given a Low GI Breakfast, reduce both Lunch and Supper meals?

In order to answer this we did a similar study looking at what happens to the lunch event and supper event in a similar group of children fed a low or high GI breakfast. We found that over 24 hours children eating a low GI breakfast ate less calories, not as significant as the previous study but in the right direction.

I want to quickly end by sharing with you a study on humans that was conducted in my laboratory a few months ago. We had about twelve subjects who were slightly overweight and we have them for eight weeks a low GI food regime. They came to our laboratory and were given all low GI foods. After eight weeks on a low GI diet their mean weight loss was about 4 kgs from eight weeks. Systolic pressure has come down, glucose has come down, cholesterol has come down, TG not much change, HDL has also slightly come down. So the take home message is that a low GI diet is not only compatible to their acceptability but more importantly it allows very dramatic weight loss. One woman lost 7kgs in eight weeks, an impressive weight loss.

So what I want to share with you is that a low GI diet is a feasible diet for weight loss and for other areas of metabolic control and so what are my conclusions – a low GI diet produces a small rise of blood glucose that can control and contain diabetics, it improves the body's sensitivity to insulin, it may also help in weight loss and lower blood lipids. We also know that it has a contributory role in reducing hunger and appetite. I think we certainly need much larger studies as we are just scratching the surface. I think GI will have a multiplicity of roles in regulating blood glucose control and lipid metabolism. Bread and bakery products are ideal vehicles in my vocabulary for modifying these as necessary more research.

And I want to end with this, by commenting that the bakery products have played a major role in the provision of micronutrients since the 1950's. You, representing the bakery industry have an unbridled connection with history from the time of Moses, and of course more importantly you have made a major contribution to the micronutrient provision of this nation due to fortification of flour. I believe that the Glycaemic index provides you with an enormous opportunity and challenge to take this area forwarding helping people combat the chronic diseases of this century: Diabetes, CVD, and Hypertension.

Thank you very much indeed.

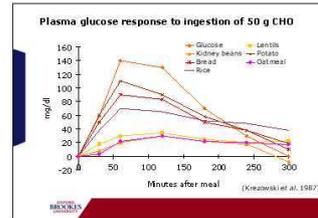
**OXFORD BROOKES UNIVERSITY**

Glycaemic Index of Foods: Challenges & opportunities for the food industry

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20 March 2006

**Topics to be covered**

- Concept of GI
- Factors influencing GI
- Overview of GI, health and well-being
- Future directions and overall conclusion



**Glycaemic index**

- The glycaemic index (GI) is a method of ranking foods on a scale according to the extent to which foods raise blood glucose levels after ingestion
- Carbohydrate foods that break down quickly during digestion have the highest GI values - their blood glucose response is fast and high
- Carbohydrates which break down slowly, releasing glucose gradually into the bloodstream, have low GI factors

**GI calculation**

$$\text{GI of a food} = \frac{\text{Incremental area under the blood glucose response curve for the test food containing 50 g available carbohydrate}}{\text{Corresponding area after equi-carbohydrate portion of a standard food}} \times 100$$

**How is GI determined?**

- Typical testing routine involves 12-15 subjects (age range 18-40 years)
- Subjects arrive at the laboratory after an overnight fast
- Finger-prim blood sample taken at time zero
- Subjects consume 50 g glucose in 200 ml water and blood samples taken at 15, 30, 45, 60, 90 and 120 mins
- This procedure is done three times on each subject (on separate days with a minimum gap of 1 day between tests)
- Subjects then consume 50 g available carbohydrate from the test sample and blood samples are taken at time intervals as above

**GI values of foods - glucose vs white bread**

Food	GI value (Glucose = 100)	GI value (White bread = 100)
Levins	30	52
Aglio	36	52
Dark chocolate	41	39
Baked beans	46	49
White corn (bread)	50	71
Cornflake	52	74
Coconut	67	86
White bread	70	100
Dark chocolate	84	117

(Foster-Fowler et al. 2002)

**GI testing of foods at Oxford Brookes**

- FAO/WHO protocol (Carbohydrate in Human Nutrition, 1990)
- The GI rating of a food must be tested physiologically in a specialised laboratory
- Only a few nutrition research groups around the world currently provide a legitimate testing service
- Oxford Brookes University is working with Tesco to study the effects of low- and high-GI foods and to develop products that have lower GI ratings
- Tesco has commissioned Oxford Brookes University to develop 'GI' for GI testing
- Tesco has tested over 300 foods for GI (Dec 2005)

**Published work**

Glycaemic index values for commercially available potatoes in Great Britain  
Henry et al. 2005, *British Journal of Nutrition* 94, 917-921.

Glycaemic index and glycaemic load values of commercially available products in the UK  
Henry et al. 2005, *British Journal of Nutrition* 94, 922-930.

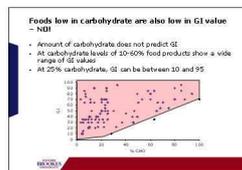
We have GI values of over 500 foods - the largest database in Europe.

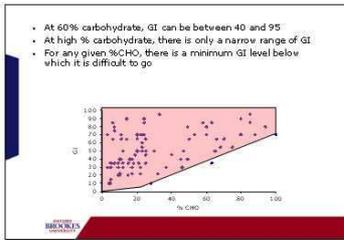
**Classification**

- Low GI 55 or less
- Medium GI 56-69 inclusive
- High GI 70 or more

**Biscuits: les céréales qui dynamisent le petit déjeuner**

**Le meilleur des céréales dans un biscuit**





**Low-, medium- and high-GI foods tested at Oxford Brookes University**

Low-GI foods (55)	Medium-GI foods (56-69)
<ul style="list-style-type: none"> <li>Bran flakes</li> <li>Alf-bran</li> <li>Pasta</li> <li>Lentils</li> <li>Butter beans</li> </ul>	<ul style="list-style-type: none"> <li>Wholemeal pitta bread</li> <li>Malt loaf</li> <li>Muesli</li> <li>Fruit &amp; fibre</li> <li>Basmati rice</li> </ul>
High-GI foods (70)	
<ul style="list-style-type: none"> <li>Com flakes</li> <li>Puffed wheat</li> <li>Baked potato</li> <li>Fruit loaf</li> <li>Instant porridge</li> </ul>	

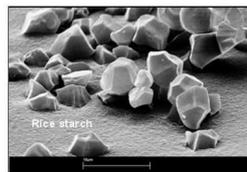
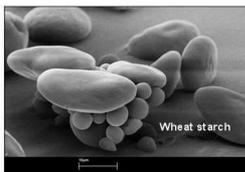


- Food factors that influence glycaemic response**
- Nature and amount of carbohydrate
  - Nature of the monosaccharide components - glucose, fructose, galactose
  - Nature of the starch - amylose, amylopectin, resistant starch
  - Cooking or food processing - degree of gelatinisation of starch, particle size, food form, cellular structure
  - Other food components - fat and protein, dietary fibre, antioxidants, organic acids

**Food ingredient/macronutrient effect**

Food	GI value	GI rating
Pasta (white)	95	Low
Pasta (white) with tomato sauce	35	Low
Pasta (white) with tuna	30	Low
Toast (white)	65	Medium
Toast (white) with cheese	35	Low
Toast (white) with baked beans	50	Low

- Starch behaviour**
- In native form, starch is a "hard" structure that absorbs little water and is difficult to digest
  - Cooking - boiling, baking, extrusion - causes starch to swell very greatly
  - Cooked starch has a high viscosity and is easy to digest



- High amylose starches**
- Normally obtained from specific varieties of maize
  - Do not swell or gelatinise until temperature exceeds 100°C
  - Can therefore be used as ingredients to lower GI of foods (resistant starch)
  - Resistant starch and other modified carbohydrates can be used to reduce the GI of foods

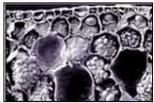
- Rate of starch breakdown will influence GI**
- Propose that it is controlled by 3 main factors
  - Access of enzymes to starch - cell wall as a barrier, protein matrix
  - Susceptibility of starch to hydrolysis - structural breakdown, molecular breakdown
  - Presence of other specific nutrients which affect stomach emptying and viscosity of gut contents

- Structure of pulses**
- Low GI (25-45)
  - Relatively thick cell walls
  - Cell walls resilient against cooking
- 

- Bread structure**
- Medium-high GI
  - Starch swells as much as possible
  - Not enough protein to surround starch
  - Highly diverse structure from fine spongy texture to dense mass of grains
  - Opportunities for modification via ingredients
  - Low-GI breads now available

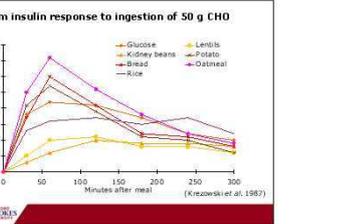
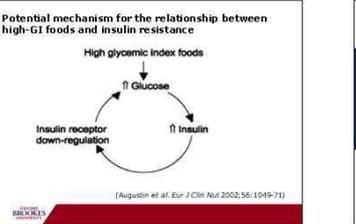
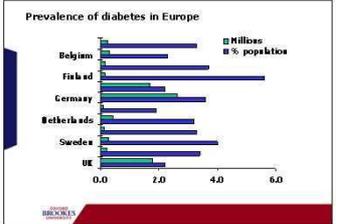
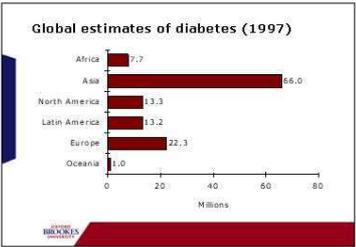
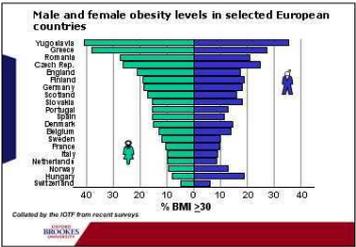
### Peanuts: very low GI (14). Why?

- Thick, resilient cell walls enclose limited amount of starch



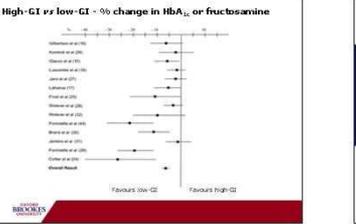
### The role of GI on health and well-being

- Three major diseases in the UK:
  - Obesity
  - Diabetes
  - Cardiovascular disease
- How does a low-GI diet affect these?



### Low-GI diets in the management of diabetes

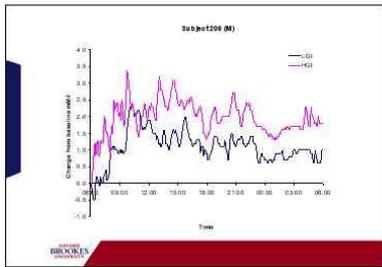
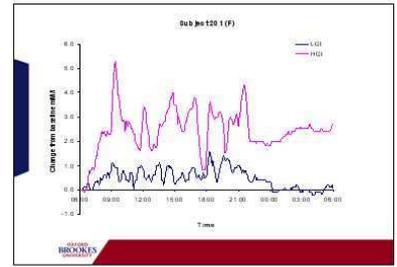
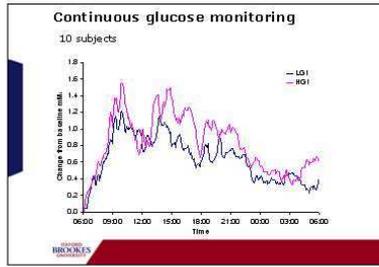
- Meta-analysis of randomised controlled trials [Brand-Miller et al, Diabetes Care 2003;26:2261-7]
- 14 studies included in the final analysis (356 subjects)
  - 203 type 1 diabetes; 153 type 2 diabetes
- After an average duration of 10 weeks, subjects with type 1 and type 2 diabetes who followed a low-GI diet had lower levels of HbA<sub>1c</sub> (0.4%) and fructosamine (0.2 mmol/l)
- Clinically important reduction in HbA<sub>1c</sub>



### Meta-analysis of the health effects of using the glycaemic index in meal-planning

Oppeman et al, 2004, British Journal of Nutrition 92, 367-381.

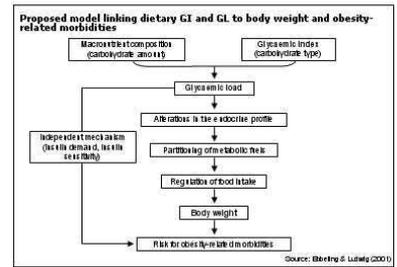
"The present meta-analysis supports the use of GI as a scientifically based tool to enable selection of carbohydrate-containing foods to reduce total cholesterol and to improve overall metabolic control of diabetes."



### Energy balance and obesity

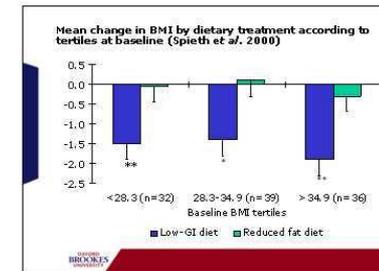
Energy balance = Energy Intake - Energy Expenditure

- You will only be in positive energy balance when energy intake exceeds energy expenditure
- Positive energy balance leads to obesity



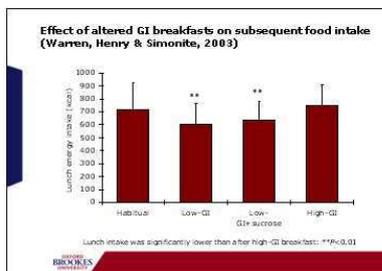
### Three recent papers on GI and obesity

- A low-glycemic index diet in the treatment of pediatric obesity [Spieth *et al.*, *Arch Pediatr Adolesc Med* 2000;154:947-51]
- High glycaemic index foods, overeating & obesity [Ludwig *et al.*, *Pediatrics* 1999;103:261-6]
- Low glycaemic index breakfasts and reduced food intake in preadolescent children [Warren *et al.*, *Pediatrics* 2003;112:e414-9]



### Effect of altered GI breakfasts on subsequent food intake (Warren, Henry & Simonite, 2003)

- Low-GI
  - All-Bran
  - non-Swiss-style toasted muesli
  - traditional porridge
  - soya and linseed bread
- Low-GI and added sucrose
  - sucrose added to provide additional 10% energy
- High-GI
  - Corn Flakes
  - Coco Pops
  - Rice Krispies
  - White bread



### Test breakfasts

**Low-GI breakfast**

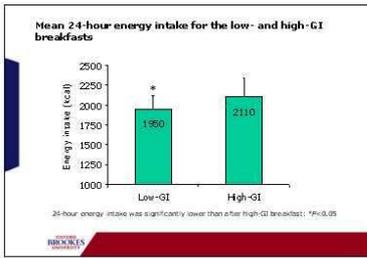
- Soya & linseed bread (with low fat spread and diabetic jam)
- All-Bran
- Porridge
  - cereals served with either skimmed, semi-skimmed or whole milk
- All breakfasts served with 190ml unsweetened fruit juice

**High-GI breakfast**

- Wholemeal bread (with low fat spread and jam)
- Weetabix
- Shreddies
  - cereals served with whole milk
- All breakfasts served with 190ml of low sugar squash + teaspoon of glucose powder (to increase the GI)

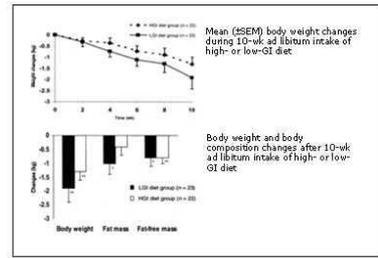
### Nutritional composition of test breakfasts

	Mean low-GI breakfast	Mean high-GI breakfast
Breakfast GI	46	77
Energy (kcal)	300	299
Protein (g)	10.7	7.6
Fat (g)	6.6	5.2
CHO (g)	49.4	55.5
NSP (g)	5.8	5.2



### Sloth *et al.* AJCN 2004;80:337-47

- Methods**
  - 45 healthy overweight women
  - 10-wk parallel, randomised, intervention with 2 groups: high-GI or low-GI
  - High or low-GI foods (identical in energy, energy density, dietary fibre and macronutrient composition) replaced subjects' usual carbohydrate-rich foods
- Results**
  - No significant between-group difference in body weight ( $P=0.31$ )
  - 10% ↓ LDLc in low-GI group ( $P<0.05$ )
  - Larger decrease in TC in low-GI group



### Pawlak DB, Kushner JA & Ludwig DS. *Lancet* 2004;364:778-85

- Male rats
  - High-GI diet ( $n = 11$ )
  - Low-GI diet ( $n = 10$ )
- Controlled diet to maintain bodyweight between the groups for 18 weeks
- Identical macronutrient composition (69% CHO, 20% protein, 11% fat as percentage of energy)
- Type of starch
  - High-GI 100% amylopectin
  - Low-GI 60% amylose / 40% amylopectin

### Body composition changes (week 17)

	Mean (SE) in group	
	High-GI	Low-GI
Bodyweight (g)	547.2 (13.4)	549.2 (15.2)
Body fat (g)	97.8 (13.6)	57.3 (7.2)
Lean body mass (g)	450.1 (9.6)	491.9 (11.7)
Adiposity (%)	17.5 (2.1)	10.3 (1.1)

- Consumption of a high-GI diet per se adversely affects body composition and risk factors for diabetes and CVD in animal models
- Adiposity was significantly greater in the high-GI group than in the low-GI group
- At 18 weeks, high-GI animals had more abdominal fat or "central adiposity" compared to the low-GI animals

### GI Diet & weight loss

### List of food for the low-GI weightloss study

Breakfast	GI & SEM
Bread	
-Crusty seeded wheat bread	52 ± 8
-Burger bread	31 ± 3
Cereals	
-Wholewheat muesli	56 ± 6
-18 fibre bran	61 ± 10
- Bran flakes	50 ± 7
Yogurt	
-Low fat fruit	49 ± 12

### List of food for the low-GI weightloss study: continued

Lunch	GI & SEM
Soup	
-Lentil	60
-Bread	
-Wholemeal pizza bread	56 ± 13
-Crackers bread	
Sandwich filling	
-Tuna	
-Cheese (cheddar)	
-Ham	
Hamburger	
-Ham	
Boiled beans	60 ± 3

### List of food for the low-GI weightloss study: continued

Dinner	GI & SEM
McDonalds burger	
-Baked rice	52 ± 11
-Ragi pasta	54 ± 11
Roasted vegetable	
-Lentils, beef	47 ± 7
-Lentils, meat	28 ± 4
-Lentils, vegetable	20 ± 6
-Cauliflower, vegetable	15 ± 6
-Pasta, vegetable	23 ± 6

### List of food for the low-GI weightloss study: continued

Dinner	GI & SEM
Mexican	
-Fajitas, chicken	42 ± 14
Oriental	
-Chow mein, chicken	47 ± 7
-Sweet & sour chicken with noodles	41 ± 7
-Chili beef noodles	42 ± 4
British	
-Cumberland fish pie	49 ± 5
-Cumberland pie	28 ± 6
-Beef & ale casserole	53 ± 12
-Steak & ale with cheddar mash	48 ± 12
-Mushroom stragganet with rice	26 ± 6

### List of food for the low-GI weightloss study: continued

Snacks	GI & SEM
Dried fruit	
-Apricot	32 ± 7
-Almonds	35 ± 5
-Nuts	43 ± 15
Nuts	
-Cashew	29 ± 6
-Walnuts	24 ± 10

### Characteristics of the subjects in the low-GI weight loss study (Baseline, week 4 and week 8)

	Baseline (mean ± SD)	Week 4 (mean ± SD)	Week 8 (mean ± SD)
Characteristics			
No. of subjects	25	25	25
Age (yr)	47 ± 10.9	47 ± 10.9	47 ± 10.9
Body mass index	32.6 ± 3.3	31.6 ± 3.2	30.9 ± 3.3
Weight	96.3 ± 19.4	94.2 ± 19.3	93.3 ± 19.2
Baseline blood pressure	140/10 ± 27/20	137/9 ± 26/18	135/9 ± 26/18
Baseline blood glucose	65.0 ± 13.2	65.7 ± 13.8	65.7 ± 13.1
Diastolic (mean)	1.00 ± 0.12	0.97 ± 0.13	0.94 ± 0.14
Diastolic (SD)	0.16 ± 0.16	0.16 ± 0.15	0.16 ± 0.16
Triglycerides (mean)	1.57 ± 0.72	1.46 ± 0.71	1.47 ± 0.69
LDL-Cholesterol (mean)	1.28 ± 0.38	1.11 ± 0.22	1.10 ± 0.42

**Body weight of the subjects in the low-GI weight loss study (Base-line and week 8)**

Subject No.	Baseline Weight(kg)	Week 8 Weight(kg)	Weightloss
1	91.60	80.70	2.9
2	81.20	77.00	3.4
3	100.20	104.90	4.7
4	95.20	79.40	7.8
5	78.10	74.00	3.6
6	81.50	70.20	3.3
7	88.30	81.00	6.7
8	98.70	96.00	2.1
9	73.40	73.00	3.9
10	68.90	66.30	2.2
11	99.00	89.90	3.1

- Conclusions (I)**
- Low-GI foods produce a smaller rise in blood sugar and can help control established diabetes
  - Low-GI diets can improve the body's sensitivity to insulin
  - Low-GI diets can help people lose weight and lower blood lipids
  - Foods with a low-GI help people control their hunger, their appetite and their blood sugar levels
  - Low-GI foods may be a useful dietary intervention for people suffering with Metabolic Syndrome

- Conclusions (II)**
- Further long-term research (1 year or more) on GI and energy regulation is required as almost all studies have been short-term
  - GI foods appear to have multiplicity roles: in energy regulation, insulin response and lipid metabolism
  - Bread and bakery products are an ideal vehicle for modification if necessary

- Conclusions (III)**
- The concept of GI is going to revolutionise our nutritional thinking
  - Whilst GI/GL is not a nutritional panacea, mounting evidence suggests that it has a role in weight loss, diabetes and hyperlipidaemia
  - Innovative ways to translate the concept of GI to the average consumer needs to be seriously explored
  - The future challenge is to nurture collaborative activities between food industry, policy makers, FSA/EFSA and academics

- The Future**
- Further research on GI and energy regulation is required with an emphasis on long-term well controlled study designs
  - A better understanding of the relationship between food structure and physiological response to foods
  - The concept of GI may be easily and successfully integrated with other dietary interventions and new manufacturing practices
  - Bakery products have played a major role in the provision of micronutrients Their ability to have a major impact on the health of the nation is limitless!

Diet may play a more important role in the prevention and treatment of chronic diseases than tablets and medication.

Sessional Chairman: Well there you are ladies and gentlemen. I told you it would be a fascinating talk, touched with a little bit of humour in there. Jeya has said he will answer questions, as many questions as you like to put in as short a time as possible. Have we got the first question?

Question: Sylvia Macdonald, Croydon

A lot of the national press have moved on from GI to GL, Glycaemic loading, can you explain what it is and whether it merits this new impact?

Answer: Thank you very much, I am glad you asked the question. Glycaemic index is a factor that is intrinsic to the food. Let me give you an example. Let's take for the sake of argument – All in One has a GI of about 45. Whether you eat one slice or 50 slices of All in One, the GI does not change. But the GL is Glycaemic index times the quantity of carbohydrate in the food that you consume. So one slice of bread will have, for the sake of argument, 15 grams of carbohydrates, so the GL will be 15 times 40%. If you had six slices it will be 6 times 15, which is 90 times 40%. So therefore the GL is a concept that I think is useful to have, but in general, I'm making sweeping generalisation, in our analysis most foods that have a low GI also have a medium to low GL. So although GL combines quality which a GI value, and quantity which is the amount of carbohydrate in one factor, it's a more complex idea to try and get your head around. So my view is that let's try to get people to understand GI before we even talk about GL because as I said the auto correlation is quite strong.

Question: Paul Heygate, Bugbrooke

I take it you don't see GI as a passing phenomenon like the Atkins diet, and secondly because I want to be slightly provocative, do you think legislation is better than education?

Answer: The first question first. I really don't believe that GI is a passing cloud for three reasons. One is that although we use the term GI diet, it is not really a diet because it is a lifestyle pattern. Number two is that a GI diet does not in any way proscribe or prescribe. Meaning it doesn't say don't eat that. You can actually eat a high GI diet as well, or a high GI food. It simply says a low GI has got a metabolic rate and therefore it's a part of a broader palette, so its highly acceptable and you don't get bad breath, because you are on a high protein diet that was a major problem, and constipation too, it's a double whammy. And the third thing as I said a moment ago is that a low GI diet is highly compatible with your lifestyle. It's got a whole range of food you can choose from as we have shown in our own study. There's absolutely no doubt in my mind that in terms of pre-diabetic and diabetic control and high cholesterol control, low GI diet is absolutely the way forward. So I think it's going to stay and its going to get bigger because I think the scientific evidence is much stronger, much more overwhelming and therefore much more supported.

Your second question – should we legislate or educate. I think we probably need a mixture of both, because if you take something like food safety, clearly we need legislation to make things happen. But if you talk about nutrition, I'm less convinced that legislation is the way forward because I think we don't want to be proscribed from eating what you want because we live in a society where libertarian value is so important, so I think education has a role to play. But I think they should be working in tandem is my take on that.

Question: Alex Waugh, London

I was interested in your indication that bread might be high GI, but bread and butter would be low GI and that strikes me as being a bit confusing for the consumer who may look at a packet of food and see that its high GI and not necessarily make the association that I'm going to eat it in this way which will make it low GI. How do we deal with that?

Answer: I think again coming back to what Paul said it has surely got to do with education. But remember that if you have a medium to low GI bread and then you add butter to it, its going to get even lower so I think its quite important, this is why I am very, very careful in saying for heavens sake, or don't expect GI is a panacea for everybody No 1. No 2 it also doesn't proscribe you from not eating a high GI food. Very important. And No 3 what we are saying is a low GI food or a low GI constellation of foods has got a better glucose control than high GI food but fortunately most of us will be selecting foods that fall into that kind of grey area of medium to low and therefore that's what we are trying to promote. So this is very important that you don't say good and bad foods, that's not what I am here for.

Question: Ann Bruce, Crawley

I was interested in the measurements for medium GI, you were saying it's quite random, it's between 56 and 69, do you think that needs to be reviewed in the future?

Answer: - I am very reassured that from the figures I showed you of the 24 hour blood glucose values, feeding people a low and a high GI food separated out the blood glucose values. In other words Prof J Brand Millers classification although based on arbitrary nomenclature appears to have a biological impact in terms of the glucose value so Jenny brand Miller may have got it right in the low and the high, where I've got debate is the medium. I think the medium is the metaphorically hard boiled potato because it is really quite difficult to separate the GI values just by 15 units. So I think that's going to be some change.

Question: John Waterfield, Leigh

Do you think we'll ever get to the stage where it's possible to calculate the GI level rather than going through all the blood tests? I'm just thinking as a smaller manufacturer, will we always have to rely on the people who are supplying us or will we get to the stage where we can do it ourselves?

Answer: Good question. I think like all modelling work there will be an error factor. So what we have been doing quite successfully for food companies that when they want to manufacture a product, we can model for them ten different formulations which two are going to be the front runners, because if you remember these studies are quite expensive. You are talking about £2,500/3,000 each study, you can see why because they are quite time consuming.