

Dorte Hammelev

Frederiksberg HF kursus
Sønderjyllands allé 2, DK - 2000 F

Investigation of blood-glucose level in connection with a meal

Before using this procedure teachers should ensure that they follow the health and safety guidelines recommended by their institution or local authority. (In the UK, teachers should refer to “Topics in Safety”, published by the Association for Science Education, College Lane, Hatfield, Herts AL20 9AA. 3^{ed} edition 2001, ISBN 0 86357 316 9.)

Introduction

The carbohydrates of the diet make the blood-glucose level rise. Carbohydrates can be divided into three basic types of molecules: mono-, di- and polysaccharides. After ingestion all three kinds are broken down in the alimentary canal to monosaccharide – and later – after passage through the liver all the monosaccharide are turned into glucose.

Earlier it was thought that polysaccharides were more valuable than mono- and disaccharides, since the enzymatic digestion in the gut delayed the absorption of starch-rich nutrients. Today this is considered incorrect. The amount of enzymes for digestion is so high that there is no delay in breaking down the larger molecules into smaller monosaccharides. The amount and the kind of fibres in the food is instead of crucial importance for how fast and how much a food product (alimento) contributes to increase in blood-glucose level. Potatoes makes the blood-glucose level rise as fast as if plain glucose is eaten and the conditions are similar if you eat white bread – bread baked of wheat-flour without kernels.

There are in principle two types of fibres in food: those that are water-soluble and those that are insoluble in water. There are especially a lot of water-soluble fibres in cereal and many vegetables such as beans. In the intestine these fibres become jellylike which makes the uptake through the epithelium cells slower. The fibres can remain for such a long time in the gut that they also influence the next meal – if breakfast is rich in fibre then the following lunch will probably be influenced so that the blood-glucose level also then rises slower.

The blood-glucose level is normally between 3.5 and 8 mmol/dm³. The concentration is maintained with the help of the autonomic nerve system, several hormones and processes, the most important hormones are insulin and glucagon. Both hormones are produced in the pancreas. Insulin stimulates muscle-, lipid- and heart

*CORRESPONDENCE TO
Dorte Hammelev
Dorte Hammelev
Frederiksberg HF kursus
Sønderjyllands allé 2, DK - 2000 F
Email: dorte@centrum.dk*

cells to take up glucose, while glucagon stimulates the liver cells to release glucose into the blood. Meals and physical work are some of the processes that influence the blood-glucose level. These processes are extremely complex. You can learn more about them by visiting internet!

Glycemic index – GI

The speed of increasing blood-glucose level after a meal is of great importance for people with diabetes. The glycemic index (GI) has been developed indicating the increase of blood-glucose level occurring when you eat a special nutrient in relation to what happens when you eat the amount of carbohydrate as glucose or white bread. Glucose and white bread yield somewhat different GI, and some researchers studying nutrients choose glucose, others white bread as reference. In the following description GI values are chosen based on white bread.

For people having problems with the control of blood-glucose level it is important that it does not increase too rapidly. The increasing level and how high it rises influences the feeling of saturation, meaning that this subject is interesting for many more people than those having diabetes – people who want to keep or lose weight.

Various factors influencing the GI value of a nutrient:
• Contents of fibres – the more fibres the lower GI.
• Solid or liquid – solid food means lower GI.
• Processing of food – whole grains or pieces give lower GI than mashed or chopped.
• Boiled starch will raise the blood-glucose level faster than un-boiled starch.
• The kind of fibres – pasta and beans will give lower GI than potatoes.
• The relationship between carbohydrate, lipids and proteins – the more lipids and proteins the lower GI.
• pH – with lower pH also lower GI.
• Kind of starch molecule – the higher portion of amylose in relation to amylopectin, the lower GI.
• Kind of sugar – sugar that has to pass the liver to be converted into glucose has a lower GI.
• Milk products, especially fermented milk as buttermilk or yoghurt, decrease the GI.
• Different preparation of the food – boiling or frying will influence GI.

The table below shows examples of GI from different kinds of food. The values are average results from experiments with many persons. Individual results may

vary a lot. The results have shown that there are large individual differences on the way different nutrients influence the blood-glucose level. Thus the values below have to be used with care. See also the text below.

Food product	GI	Food product	GI
Glucose	138	Orange juice	74
Potatoes, baked	135	Oatmeal porridge	70
Precooked rice	128	Rye bread, with whole kernels	68
Cornflakes (Kelloggs)	116	Rice, parboiled	68
Watermelon	103	Lactose	65
White bread	100	Macaroni	64
Soft drink	97	Orange	62
Potatoes, steam-boiled	93	All Bran (Kelloggs)	60
Couscous	93	Peas, canned	60
Sucrose	92	Rye, with whole kernels	48
Oatmeal, un-boiled	89	Milk, 3 %	39
Danish pastry	84	Red lentils	36
Carrots, boiled	82	Grains of barley	36
Rice, jasmine	81	Fructose	27
Special K	77	Peanuts, roasted	21

GI-table of some common food products, from R. Arvidsson-Lenner, 2004. The investigation of Cornflakes and All Bran is made on products from Kellogg's. The brand-name has nothing to do with the health value of these products in comparison with products of the same type from other companies.

High GI; more than 90, average GI 70 – 90, low GI lower 70.

Is low GI-food most healthy?

Usually you eat not only one type of food, but a mixture in a meal. It is the added GI of a meal, which is of interest. Therefore it is discussed among dieticians – professionals who give advice about food – to which extent GI may be used during such advice. Supporters mean that information about GI is valuable if it is used as an indicator and with care. It is not advisable only to use the GI value without looking on the contents of the food. Roasted peanuts have a low GI since they contain a lot of lipids, but it does not mean that the product is healthy. Potatoes and carrots contain several important nutrients, as vitamins and minerals that pasta does not contain. Because of this dieticians have developed a glycemic load index (GL), an index where the content

of carbohydrates and the size of the meals are considered, as it is the total information, which is important if you want to eat in a healthy way. Then it is both the amount and relationships between the three nutritional groups, which gives important information.

GI values are based on 50 g digestible carbohydrates from each nutritional source. As already mentioned, carrots have a high GI. However, the GI table does not show that you have to eat 575 g boiled carrots to ingest 50 g carbohydrates. The energy-contents of this quantity of carrots is 718 kJ. If we compare this with peanuts, which have a GI value of 21, then you have to eat approximately 575 g to ingest 50 g carbohydrates. The ingested amount of energy then is 5142 kJ!

Feeling of saturation

Ingestion of nutrients with a high GI – giving a rapid increase in blood-glucose level – will give a fast release of a high dose of insulin into the blood. This will give a fast decrease of the blood-glucose, which gives tiredness and a feeling of hunger. If the high GI value depends on certain fibres, as for instance from potatoes, the product does not give much of a feeling of satisfaction. It can however contribute to the development of resistance of insulin.

Type-2 diabetes is very common among obese people. Because of this, such people should eat lots of fibre-rich food, which also gives a good feeling of saturation. If the GI value is too low, because of too high content of lipid, you should not eat as much of this kind of food. Treatment of people with type-2 diabetes should – if they also have a weight problem – also make use of a weight table since they must also improve the sensibility of insulin.

People that are non-diabetics could also follow the nutritional advice given to patients with type-2 diabetes.

Laboratory

Investigation of blood glucose level before and after a breakfast rich in carbohydrates

This investigation is best done as a breakfast exercise, to avoid possible effects of fiber contents from a previous meal. The person to be tested should therefore have been fasting when he/she is tested. Each person shall eat 50 g digestible carbohydrates and the meal should contain as few different kinds of food as possible. We suggest that some (at least 2) test persons should eat All Bran with maximum 150 cm³ of milk (not buttermilk) and some others (at least 2 people) should eat Cornflakes with the same amount of milk. It is also possible to eat other products – white bread or pure glucose, possibly as a soft drink. It is important that it

always is at least 2 persons who eat the same products and the same amount to show individually differenties.

Aim

To get some information about normal blood-glucose levels in different people, and to see, how the blood-glucose levels varies with the ingestion of different kinds of breakfast, rich in carbohydrates.



Figure 1. The apparatus for blood sampling and measurement of the blood sugar level.

Materials

- Breakfast products.
- Instrument for testing blood-glucose level. (People with diabetes use this daily. Can be bought from a pharmacy.)
- Testpads. (Can be bought from a pharmacy.)
- Scale to weigh the food.
- Plates and cuttlery. (**NOTE!** Do not eat in the laboratory and absolutely not from laboratory glass-ware!)

Procedure

Please observe that it is very important that blood samples are only taken from the student by him/herself to avoid infection. **It is not allowed to help a fellow student taking his/her blood sample. All safety regulations must be followed. After the investigations all test-strips and needles must be taken care of in a safe way. Ask about the regulations in your school! Check with the school nurse!**

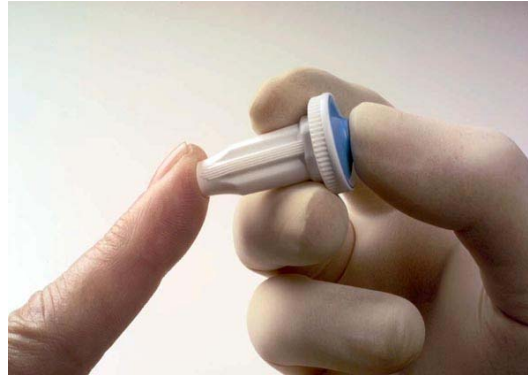


Figure 2. Blood sampling. Blood lancet från HaeMedic AB.

1. The class should be divided into groups of two students.
2. Before the meal the students investigate their own blood-glucose level = the level at fasting.
3. Choose food for breakfast. Calculate how much each student should eat of the chosen products. Use the declaration on the package for the calculation of 50 g digestible carbohydrate. Then weigh the food.
4. The students must then eat the breakfast products as fast as possible. Time 0 is when the students actually start eating.
5. The blood-glucose level should be measured at even interspaces, for example after 15 min, 30 min, 45 min, 1 h and if possible until the blood-glucose level is back to the fasting level. **The students must not eat until all measurements are completed.**
6. Write down the values in the table below.

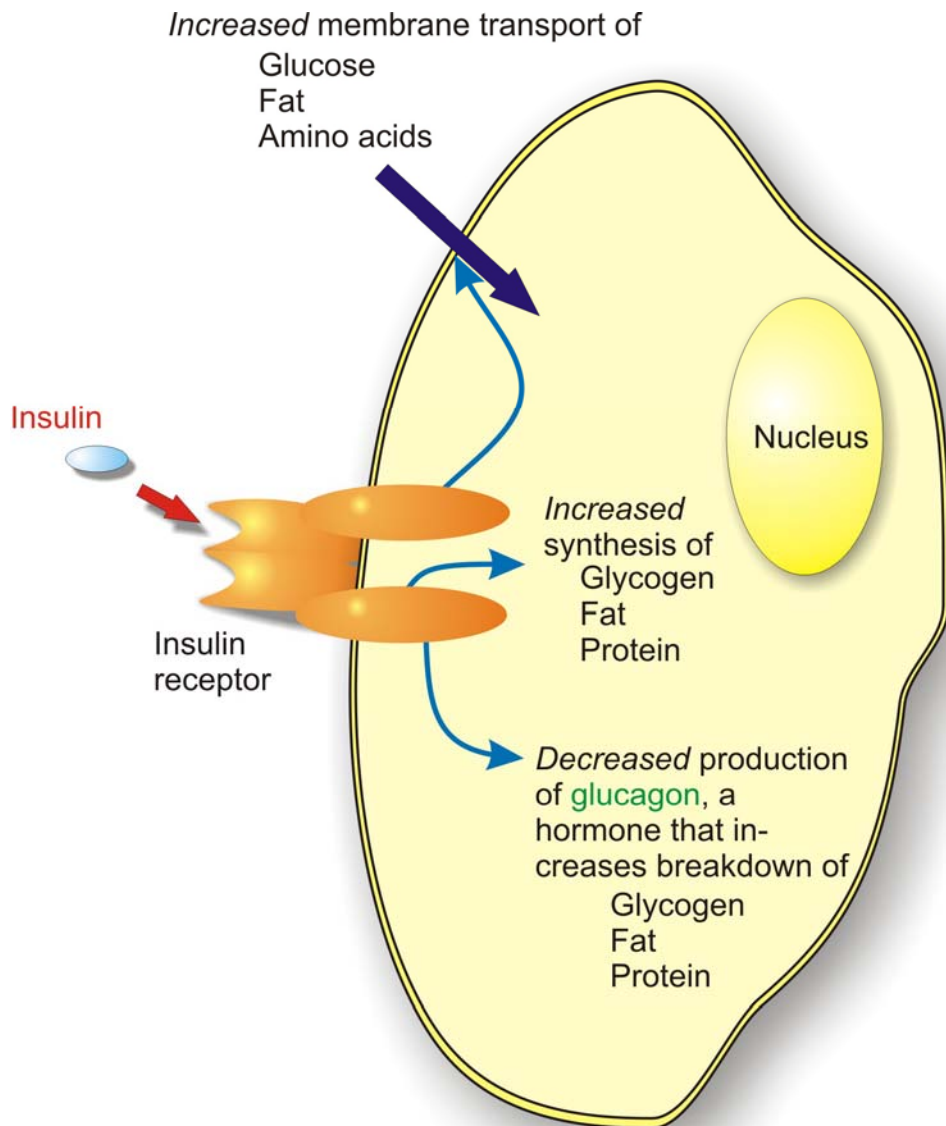
Name	Food for breakfast	0/fasting value	15 min	30 min	45 min	60 min

Results

The results can be put up as a graph, with the time as X-coordinate and blood-glucose level as Y-coordinate. Get the values from all the students.

Discussions

- a. Describe the graph and explain what happens in the body.
- b. Explain glycemic index (GI).
- c. Give a possible explanation to what happens in the body through the test period and why the blood-glucose level changes differently in different students.
- d. Give a suggestion to what could explain the individual differences.



Figur 3. Effects of insulin and glucagon on tissue cells.