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Food products — Determination of the glycaemic index (GI) and recommendation for food classification

Produits alimentaires — Détermination de l'index glycémique (IG) et recommandations relatives à la classification des aliments

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 26642 was prepared by Technical Committee ISO/TC 34, *Food products*.

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Introduction

The development of this International Standard originated from a recognized need to standardize the determination of glycaemic index (GI) of foods for practice and research purposes, particularly with its increasing use as a nutrition claim, illustrating the importance of GI within human nutrition.

The objective of this International Standard is to establish the recognized scientific method as the standard method for the determination of the GI of foods.

This International Standard is intended for use by:

a) food manufacturers;

b) accreditation bodies;

c) regulators;

d) educational institutes;

e) testing laboratories;

f) research organizations.

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This International Standard is based on a Joint FAO/WHO Expert Consultation, *Carbohydrates in human nutrition* (Reference [6]).

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Additional recommendations have been taken from References [1] to [3].

The GI is a property of the carbohydrates in different foods, specifically the blood glucose-raising ability of the digestible carbohydrates. It compares carbohydrates on a mass for mass basis in single foods or food items, in the physical state in which they are normally consumed (Reference [1]). Low GI foods are those containing carbohydrates that have less impact on blood glucose levels, because their digestion and absorption is slowed or because the sugars present (e.g. fructose, lactose) are inherently less glycaemic. When combined in actual meals, low GI foods produce less fluctuation in blood glucose and insulin levels than high GI foods. The clinical and practical value of the GI continues to be studied and there is growing consensus that there are benefits to health when low GI foods replace high GI foods in a balanced diet (Reference [2]).

Historically, not all GI values on food labels have been reliable (Reference [4]). Some claims have been based on extrapolation or inappropriate methodology. While a digestibility or hydrolysis index can be obtained by *in vitro* methods of assessing the rate of carbohydrate digestion (Reference [5]), the results should not be referred to as GI values. The method set out in this International Standard should be applied to ensure that GI values are determined by recognized methodology.

GI testing is appropriate only when the food in question contributes physiologically relevant amounts of digestible carbohydrate to a meal or diet. For the purposes of this International Standard, the minimum amount is specified as 10 g or more of glycaemic carbohydrate per serving. Low-digestibility or non-digestible carbohydrates (resistant starch, some sugar alcohols, polydextrose, etc.) are not to be intentionally counted in the specified carbohydrate portion (50 g or 25 g) used in GI testing.

Small amounts of resistant starch may be inadvertently included because the methods of assay of starch are not yet adequate to clearly differentiate between digestible and non-digestible starch. Foods containing large amounts of low-digestibility carbohydrates or resistant starch are not suitable for GI testing if the amounts consumed during the test are likely to provoke gastrointestinal discomfort.

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Caution should be exercised with foods containing significant amounts of low-digestibility carbohydrates. By definition, a low GI food contains glycaemic carbohydrate, i.e. “providing carbohydrate for metabolism” (Reference [6]). Distinguishing between low-GI carbohydrate-containing foods and sources of low-digestibility carbohydrate or low carbohydrate content is important.

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Food products — Determination of the glycaemic index (GI) and recommendation for food classification

1 Scope

This International Standard specifies a method for the determination of the glycaemic index (GI) of carbohydrates in foods.

This International Standard defines the GI, outlines qualifying factors, and specifies requirements for its application.

This International Standard recommends criteria for classification of foods into low, medium and high GI.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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2.1
blood glucose response
change in blood glucose concentration over a 2 h period following the start of ingestion of the test or reference food

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2.2
carbohydrate portion
weighed portion of food containing either 50 g of glycaemic carbohydrate or, if the portion size is unreasonably large, 25 g of glycaemic carbohydrate

2.3
coefficient of variation
CV
⟨positive random variable⟩ standard deviation divided by the mean

[ISO 3534-1:2006[11], 2.38]

NOTE In the context of this International Standard, the CV is expressed as a percentage, i.e the ratio of the standard deviation to the mean is multiplied by 100.

2.4
glycaemic carbohydrate
available carbohydrate
carbohydrate absorbed into the bloodstream as carbohydrate and capable of increasing blood glucose levels when consumed

NOTE 1 The glycaemic carbohydrate content is total carbohydrate content minus non-glycaemic carbohydrate (see 2.8) content.

NOTE 2 Some glycaemic carbohydrate can be slowly absorbed and have minimal effect on blood glucose levels.

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2.5
glycaemic index
GI
property of the carbohydrate in different foods, specifically the blood glucose-raising ability of the digestible carbohydrates in a given food

NOTE 1 In common usage, this property is referred to simply as the GI of the food. It is defined as the *incremental area under the* (*blood glucose response) curve* (IAUC) after consumption of the carbohydrate portion (see 2.2*)* of a test food expressed as a percentage of the average IAUC response to the same amount of carbohydrate from a *reference food* (see 2.11 and 5.4.1) taken by the *same subject* (see 5.3) on a separate occasion.

NOTE 2 The italicized terms are defined because alternate interpretations may affect the final results obtained.

2.6
incremental area under the curve
IAUC
area under the curve calculated as the incremental area under the blood glucose response curve, ignoring the area beneath the fasting concentration

NOTE The IAUC can be calculated geometrically by applying the trapezoid rule (see Clause 7 for details).

2.7
***in vivo* GI testing**
glycaemic index testing carried out by the determination of glycaemic (blood glucose) responses in human volunteers

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2.8
non-glycaemic carbohydrate
non-digestible carbohydrate including fibre
carbohydrate largely escaping digestion in the small intestine and not directly providing carbohydrate for metabolism

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NOTE Non-glycaemic carbohydrate is, wherever possible, excluded from the determination of the carbohydrate portion for GI testing (see Table A.1).

EXAMPLE Partly or completely non-glycaemic carbohydrates include: hydrogenated mono- and disaccharides (synonyms include sugar alcohols, polyols); non-digestible oligosaccharides (fructooligosaccharides, oligofructose, inulin); galactooligosaccharides; and xylooligosaccharides. See Annex A.

2.9
outlier
member of a set of values which is inconsistent with the other members of that set

[ISO 5725-1:1994[12], 3.21]

EXAMPLE GI value for a particular subject that falls outside the range of $\overline{I}_{\mathrm{G}} \pm 2s$, where $\overline{I}_{\mathrm{G}}$ is the mean and s the standard deviation, of a group of 10 or more.

2.10
per serving
amount of a normal single serve of the test food as per common use

2.11
reference food
glucose, having by definition a GI of 100

2.12
test food
food whose GI value is being determined

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3 Classification of GI

This International Standard recommends a classification of foods as low, medium or high GI (see Annex B).

4 Qualifying factors

The GI value of a food shall be applied only to the specific test food in the physical state in which it was consumed. The qualifying factors shall be:

a) only tested foods shall have a GI assigned;

b) the method by which glycaemic carbohydrate has been obtained, as well as the glycaemic carbohydrate content, shall be provided in the test report.

The GI of heterogeneous foods can only be determined by testing according to this International Standard and not by mathematical calculation of GI of individual ingredients or food items.

Small formulation changes and seasonal variations in ingredients do not dictate re-testing.

Re-testing may be required when the:

1) formulation of the product is changed by changing the macronutrient composition;

2) processing method changes;

3) concentration, osmolality, acidity or other physical or chemical factor changes.

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5 Requirements

5.1 Ethics committee approval

The testing organization (laboratory) shall obtain written, ethics clearance from an appropriate human research ethics committee, and shall consider and address relevant issues raised in the national statement on ethical conduct of research involving humans and other relevant guidelines, available in the country. Individual countries should apply their own guidelines.

5.2 Testing facility

The testing organization shall have a food preparatory area separate from that in which blood is taken and appropriate instrumentation and consumables to analyse blood glucose content according to acceptable methodology (see 7.1).

5.3 Subjects

5.3.1 Inclusion and exclusion criteria

Selection of a minimum of 10 healthy subjects shall be made on the basis of:

a) no known food allergy or intolerance;

b) no medications known to affect glucose tolerance (excluding oral contraceptives) — stable doses of oral contraceptives, acetylsalicylic acid, thyroxin, vitamins and mineral supplements or drugs to treat hypertension or osteoporosis are acceptable.

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Exclusion of subjects shall be made on the basis of:

1) a known history of diabetes mellitus or the use of antihyperglycaemic drugs or insulin to treat diabetes and related conditions;

2) a major medical or surgical event requiring hospitalization within the preceding 3 months;

3) the presence of disease or drug(s) which influence digestion and absorption of nutrients;

4) the use of steroids, protease inhibitors or antipsychotics (all of which have major effects on glucose metabolism and body fat distribution).

5.3.2 Management

On initial presentation, subjects shall be given:

a) a participant information and consent form;

b) details of the test protocol;

c) information on the risks involved in participation.

The testing organization shall obtain informed consent before the start of testing.

5.3.3 Test conditions

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The subjects shall take no:

a) food or drink other than water for 10 h or more prior to the test;

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b) alcohol on the previous evening;

c) vigorous exercise on the morning of the test.

5.4 Reference food

5.4.1 Acceptable reference foods

The acceptable reference foods shall be as follows:

a) anhydrous glucose powder (50 g);

b) dextrose (glucose monohydrate, 55 g);

c) commercial solution used for the oral glucose tolerance test containing glucose (50 g);

d) white bread or other specific carbohydrate food of consistent composition and GI.

5.4.2 Preparation

For anhydrous glucose [5.4.1a)], dissolve 50 g (or 25 g, see 2.2) of powder in 250 ml of water, refrigerate and use within 72 h.

The amount of glycaemic carbohydrate in the reference food shall equal that of the food test portion (see 2.2).

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5.4.3 Use of an alternative reference food

The use of an alternative reference food [5.4.1d)] is acceptable provided its content of glycaemic carbohydrate is standardized and its GI relative to glucose has been established and verified as consistent by the laboratory using it.

Final GI values obtained using reference foods other than glucose shall always be expressed relative to glucose. For example, the GI of white bread, relative to glucose, is 71. Thus, if a test food elicits a glycaemic response of 80 % that of white bread, its GI value is $80 \times 0{,}71 = 56{,}8 \approx 57$ after rounding.

5.4.4 Test procedure

The reference food shall be tested in each subject at least two and preferably three times on separate days within the immediate 3 month period surrounding the testing of the product in accordance with Clause 6.

5.4.5 Results

The blood glucose response to the reference food shall be expressed as the IAUC.

The mean within-subject CV for the reference food for the group of subjects tested shall be $\leqslant$ 30 %.

If the mean CV is greater than 30 %, one outlying result for the reference test in each subject can be deleted, provided the subject has done the reference test three times.

5.5 Test food

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5.5.1 Carbohydrate portion

The test food shall contain 50 g of glycaemic carbohydrate. The full amount should be consumable within the time frame of 12 min to 15 min (see 6.3).

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With the exception of concentrated sources of glycaemic carbohydrates, foods containing less than 10 g glycaemic carbohydrate per regular serving should not be tested for their GI.

NOTE A carbohydrate portion of 25 g can be used for foods which have a lower concentration of carbohydrates, i.e. where the bulk of food providing 50 g is unreasonably large, for example fruits.

5.5.2 Preparation

Prepare the test food in accordance with the instructions on the food label. Where milk is normally added, e.g. breakfast cereals, use water instead.

IMPORTANT — Because the addition of milk influences the final GI of some products, but not others, the GI of breakfast cereals and powdered beverages needs to be determined with the addition of water and not milk.

5.5.3 Testing of multiple flavours of a single product

For products that are available in various flavours with essentially identical macronutrient composition, two flavours, e.g. strawberry, raspberry, may be tested within one group of subjects (at least five subjects test each flavour). The final GI value in 10 or more subjects is reported as the GI of both flavours. Notwithstanding this rule, if the two flavours produce statistically different GI values ($p < 0{,}05$), the individual flavours should be tested in 10 or more subjects.

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