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Cereals and cereal products — Common wheat (*Triticum aestivum* L.) — Determination of Alveograph properties of dough at constant hydration from commercial or test flours and test milling methodology

*Céréales et produits céréaliers — Blé tendre (*Triticum aestivum* L.) — Détermination des propriétés alvéographiques d'une pâte à hydratation constante de farine industrielle ou d'essai et méthodologie pour la mouture d'essai*

Reference number
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 34, *Food products*, Subcommittee SC 4, *Cereals and pulses*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 338, *Cereal and cereal products,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 27971:2015), which has been technically revised.

The main changes are as follows:

— the oldest instruments (before AlveoNG) have been removed;

— the latest instruments (AlveoPC and Alveolab) have been added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The end-use value of wheat is determined by a number of properties that are useful in the manufacture of baked products such as bread, rusks and biscuits.

Such properties include the important viscoelastic (rheological) properties of dough formed as a result of flour hydration and kneading. An Alveograph is used to study the main parameters by subjecting a dough test piece to biaxial extension (producing a dough bubble) by inflating it with air, which is similar to the deformation to which it is subjected during bread dough fermentation.

Recording the pressure generated inside the bubble throughout the deformation of the dough test piece until it ruptures provides information on the following:

a) The resistance of the dough to deformation, or its stiffness. It is expressed by the maximum pressure parameter, P.

b) The extensibility or the possibility of inflating the dough to form a bubble. It is expressed by the mean of the abscissa value at rupture, L, converted to the swelling index, G.

c) The elasticity of the dough during biaxial extension. It is expressed by the elasticity index, I_e.

d) The work required to deform the dough bubble until it ruptures, or its strength, which is proportional to the area of the Alveogram (sum of the pressures throughout the deformation process). It is expressed by the parameter, W.

The P/L ratio is a measurement of the balance between stiffness and extensibility.

Alveographs are commonly used throughout the wheat and flour industry, for the following purposes:

— selecting and assessing different varieties of wheat and marketing batches of wheat;

— blending different batches of wheat or flour to produce a batch with given values for the Alveographic criteria (W, P, and L) complying with the proportional laws of blending;

— assessing the proteolytic activity in wheat or flour to detect possible contamination (see Annex H for more details).

Alveographs are used both on the upstream side of the industry for marketing, selecting and assessing the different wheat varieties and on the downstream side throughout the baking industries (see References [9], [11], [12] and [13]).

Cereals and cereal products — Common wheat (*Triticum aestivum* L.) — Determination of Alveograph properties of dough at constant hydration from commercial or test flours and test milling methodology

1 Scope

This document specifies a method of determining, using an Alveograph, the rheological properties of different types of dough obtained from common wheat flour (*Triticum aestivum* L.) produced by industrial milling or laboratory milling.

It describes the Alveograph test and how to use a laboratory mill to produce flour in two stages:

— stage 1: preparation of the wheat grain for milling to make it easier to separate the bran from the endosperm;

— stage 2: the milling process, including breaking between three fluted rollers, reduction of particle size between two smooth rollers and the use of a centrifugal sieving machine to grade the products.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 835, *Laboratory glassware — Graduated pipettes*

ISO 712, *Cereals and cereal products — Determination of moisture content — Reference method*

ISO 1042, *Laboratory glassware — One-mark volumetric flasks*

ISO 12099, *Animal feeding stuffs, cereals and milled cereal products — Guidelines for the application of near infrared spectrometry*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Principle

The behaviour of dough obtained from a mixture of flour and salt water is evaluated during deformation. A dough disk (patty) is subjected to a constant air flow. At first it withstands the pressure. Subsequently, it inflates into a bubble, according to its extensibility, and ruptures. The change in the dough is measured and recorded in the form of a curve called an “Alveogram”.

5 Reagents

Unless otherwise specified, use only reagents of recognized analytical grade, and only distilled or demineralized water or water of equivalent purity.

5.1 Sodium chloride solution, obtained by dissolving (25 ± 0,2) g of sodium chloride (NaCl) in water and then making the volume up to 1 000 ml. This solution shall not be stored for more than 15 days and its temperature shall be (20 ± 2) °C when used.

5.2 Refined vegetable oil, low in polyunsaturates, such as peanut oil. It is possible to use olive oil if its acid value is less than 0,4 (determined in accordance with ISO 660[1]). Store in a dark place in a closed container and replace regularly (at least every three months).

Alternatively, **liquid paraffin** (also known as "soft petroleum paraffin"), with an acid value of less than or equal to 0,05 and the lowest possible viscosity [maximum 60 mPa·s (60 cP) at 20 °C].

5.3 Cold degreasing agent, optimum safety.

6 Apparatus

The usual laboratory apparatus and, in particular, the following shall be used.

6.1 Mechanical cleaner, fitted with sieves for wheat cleaning, in accordance with the manufacturer's instructions.

6.2 Conical or riffle sample divider.

6.3 Analytical balance, accurate to 0,01 g.

6.4 Glass burette, of 50 ml in capacity, graduated in 1 ml divisions.

6.5 Rotary blender[1)], for grain conditioning and flour homogenization, including the following components:

6.5.1 Constant speed stirrer.

6.5.2 Two worm screws integral with the flask, possibly via the stopper (one for wheat preparation, the other for flour homogenization).

6.5.3 Several wide-necked plastic flasks, 2 l capacity.

6.6 Test mill (laboratory mill)[2)], manually or automatically operated (see Annex A).

1) The CHOPIN Technologies MR2L rotary blender is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

2) The CHOPIN Technologies Chopin-Dubois CD1 test mill is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

6.7 Complete Alveograph system (see Table 1 for specifications and characteristics of the accessories) including the devices given in 6.7.1 to 6.7.3.

6.7.1 Kneading machine (see Figure 1 for the AlveoNG and AlveoPC models, and Figure 2 for the Alveolab model[3)]), with accurate temperature control, for dough sample preparation.

6.7.2 Dedicated software, to record the pressure curve as a function of time, perform the calculations and store the tests or other registration systems such as the Alveolink.

NOTE For details concerning the use of the different registration systems, see the manufacturer's instructions.

6.7.3 Alveograph[3)], for measuring the biaxial deformation of the dough test pieces (see Figure 1 for the AlveoNG and AlveoPC models, and Figure 2 for the Alveolab model), including accurate temperature control and hygrometry control for the Alveolab model, and having two rest chambers (three for the Alveolab), each containing five plates on which the dough test pieces can be arranged to rest prior to deformation.

6.8 Burette with stopcock, supplied with the apparatus (only for the AlveoNG and AlveoPC models), 160 ml capacity, graduated in divisions of 0,1 % of moisture content.

NOTE Throughout this document, "content" is expressed as a "mass fraction" (see ISO 80000-9[8]), i.e. the ratio of the mass of substance in a mixture to the total mass of the mixture.

6.9 Thermohydrograph for recording the test environment conditions (temperature and relative air humidity) as specified in 9.1 and 10.1. In the case of the Alveolab, the test conditions (temperature and humidity) around the swelling bubble are automatically checked and controlled by the device.

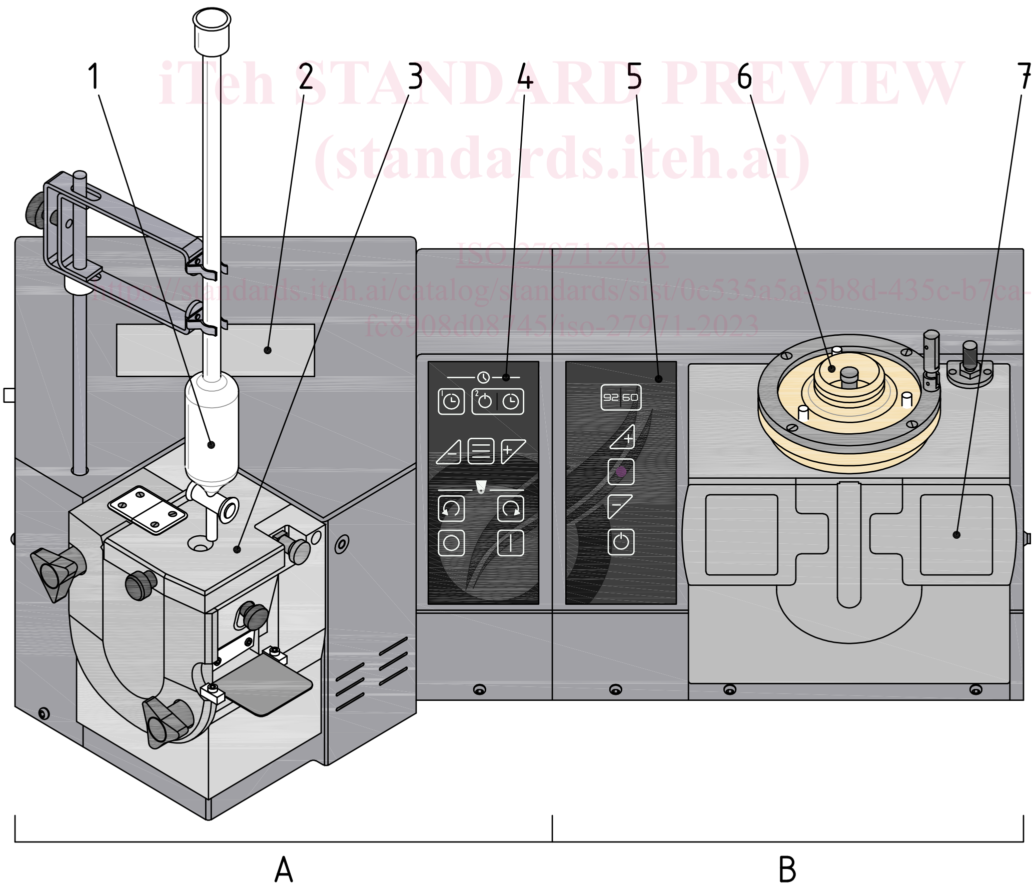
6.10 Volumetric flask, 1 000 ml capacity, conforming to the requirements of ISO 1042, class A.

6.11 Pipette, 25 ml capacity, graduated in divisions of 0,1 ml, conforming to the requirements of ISO 835, class A.

3) The methods specified in this document are based on the use of the AlveoNG, AlveoPC and Alveolab models of the CHOPIN Technologies Alveograph, which are examples of suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

Table 1 — Specifications and characteristics of the accessories required for the test

Quantity	Value and tolerance
Rotational frequency of the kneading blade	(60 ± 2) Hz
Height of sheeting guides	(12,0 ± 0,1) mm
Large diameter of the sheeting roller	(40,0 ± 0,1) mm
Small diameter of the sheeting roller	(33,3 ± 0,1) mm
Inside diameter of the dough cutter	(46,0 ± 0,5) mm
Diameter of the aperture created when the moving plate opens (which determines the effective diameter of the test piece)	(55,0 ± 0,1) mm
Theoretical distance between the fixed and moving plates after clamping (equal to the thickness of the test piece before inflation)	(2,67 ± 0,01) mm
Volume of air automatically injected to detach the test piece prior to inflating the bubble	(18 ± 2) ml
Air flow[a] ensuring inflation	(96 ± 2) l/h
[a] On the AlveoNG and AlveoPC models, to adjust the flow rate of the air generator used to inflate the bubble, fit the nozzle (see Figure 3) to create a specified pressure drop (and obtain a pressure corresponding to a height of 92 mmH_2O (12,3 kPa) on the manometer chart). The air flow rate is set with the standardized pressure drop to obtain a pressure corresponding to a height of 60 mm H_2O (8,0 kPa) on the manometer chart, i.e. (96 ± 2) l/h (see Figure 4). For the Alveolab model, this control is automatized, and no particular action is required.	



Key

A mixer

B Alveograph

1 burette for adding water

2 mixer screen

4 mixer control panel

5 Alveograph control panel

6 test plate of the Alveograph unit

7 resting chamber

3 mixing bowl

Figure 1 — Mixer and Alveograph part of the AlveoNG and AlveoPC models

Key

1 mixing bowl

2 water injection nozzle

3 Aveolab control panel

4 Alveograph test chamber

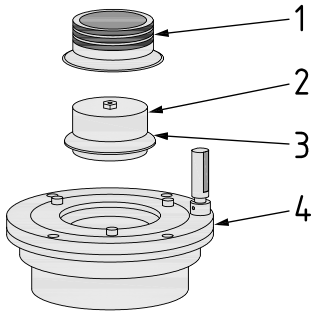
5 storage compartment for accessories

6 dough collector and humidifier

7 resting chamber

8 salt water tank

Figure 2 — Mixer and Alveograph part of the Alveolab model



Key

1 knurled ring
2 nozzle
3 nozzle holder
4 top plate

Figure 3 — Flow control system for the AlveoNG or AlveoPC models

7 Sampling

A representative wheat or flour sample should be sent to the laboratory. It shall not be damaged or changed during transport or storage.

Sampling is not part of the method specified in this document. Recommended sampling methods are given in ISO 24333[7].

8 Preparation of the wheat for laboratory milling

8.1 Cleaning the laboratory sample

If necessary, pass the laboratory sample through a mechanical cleaner (6.1) to ensure that all stones and metal fragments are removed and to avoid damaging the rollers during milling. A magnetic device may also be used to remove ferrous metal fragments.

8.2 Test portion

The test portion shall be representative of the initial wheat mass. Use the sample divider (6.2) to homogenize and divide the laboratory sample until the mass required for laboratory milling plus moisture content determination is obtained. The minimum wheat mass of the test portion for milling shall be 800 g.

8.3 Wheat moisture content determination

Determine the moisture content of the test portion as specified in ISO 712, or using a rapid device (see ISO 7700-1[6] or ISO 12099).

8.4 Wheat preparation

8.4.1 General

Preparing the wheat for milling makes it easier to separate the bran from the endosperm. The target moisture content is (16,0 ± 0,5) %.

8.4.2 Wheat with initial moisture content between 13 % and 15 % (one-stage moistening)

Using the balance (6.3), weigh a test portion (minimum 800 g) to the nearest 1 g of wheat and pour it into the blender.

Add the required amount of water (see Table B.1) to the grain from the burette (6.4) directly, or after weighing it to the nearest 0,5 g.

Immediately after adding the water, insert the stopper fitted with the worm screw provided for use with wheat into the flask, shake vigorously for a few seconds and place on the rotary blender (6.5).

Run the rotary blender for (30 ± 5) min (the time required to distribute the water evenly across the surface of the grains).

Allow it to rest for a period that brings the total time of the moistening, shaking and resting operations to (24 ± 1) h.

8.4.3 Wheat with a moisture content less than 13 % (two-stage moistening)

Since a larger volume of water is required, divide it into two halves and add in two stages during the preparation period.

Proceed as described in 8.4.2, using only half the total quantity of water required (see Table B.1).

Shake the flask as described in 8.4.2 and allow it to rest for at least 6 h.

Then add the second half of the total quantity of water between the sixth and seventh hour.

After adding the second half, shake the flask again for (30 ± 5) min, then allow it to rest for a period that brings the total time of the moistening, shaking and resting operations to (24 ± 1) h.

8.4.4 Wheat with a moisture content greater than 15 % (preliminary drying followed by moistening, as described above)

The wheat shall be dried to produce a moisture content lower than 15 %.

Spread the laboratory sample in a thin layer to optimize the exchange between the grain and the air. Allow to dry in the open air in a dry place for at least 15 h.

Perform the moisture content determination process again (see 8.3).

Then prepare the wheat as specified in 8.4.2 or 8.4.3, depending on the new moisture content.

9 Laboratory milling

9.1 General

The test mill (6.6) shall be used with the manufacturer’s settings. Additional weights shall not be used and the tension on the reduction side spring shall not be changed.

The quality of the milling process depends on several factors:

a) environmental conditions that allow the final moisture content of the flour to be between 15,0 % and 15,8 % (wheat should be milled in an ambient temperature between 18 °C and 23 °C with a relative air humidity between 50 % and 75 %);

b) condition of the sieves; the sieving area shall remain uniform – if a sieve is pierced, it shall be replaced immediately;

c) beater condition and setting: worn blades reduce the extraction rate;

d) compliance with flow rates: the efficiency of the roll and the efficiency of the sieving process are strictly dependent on a regular feed rate.

NOTE The speed at which the products pass through the sieving drum can be set by adjusting the position of the blades on the beaters, i.e. two adjustable blades in the middle and at the end of the beater on the break side, and four blades at the end on the reduction side.

9.2 Milling procedure

9.2.1 Breaking

Switch on the device.

Set the feed rate to allow 800 g of conditioned wheat to pass through the mill in (5 ± 1) min.

Pour the conditioned wheat (8.4) into the mill feed hopper and, at the same time, start the timer to check the milling time.

After the last grains of wheat have passed through, let the mill continue to operate for (180 ± 30) s to completely clear out the sieve.

When the mill stops, weigh (6.3), separately, the bran, the semolina and the flour to the nearest 0,1 g.

Calculate the percentage of semolina obtained compared with the mass of wheat used, expressing the result to one decimal place.

9.2.2 Reduction

Switch on the device.

Adjust the feed rate to allow the semolina produced in 9.2.1 to pass through the mill in (5 ± 1) min.

Pour the semolina into the feed hopper and, at the same time, start the timer to check the time.

After the last grains of semolina have passed through, let the mill continue to operate for (180 ± 30) s to completely clear out the sieve.

Repeat the above reduction procedure if the mass of semolina obtained from the break system is greater than or equal to 48 % of the mass of conditioned wheat. (Round up the values: 47,4 becomes 47 and 47,5 becomes 48.)

When the mill stops, weigh (6.3), separately, the middlings and the reduction flour to the nearest 0,1 g.

Ensure that the milling ratio (ratio of the sum of the masses of the milled products to the total conditioned wheat mass) is equal to at least 98 %.

NOTE A milling ratio less than 98 % indicates excessively worn beaters or an obstruction in the sieves, causing some of the product to remain inside the sieving drum.

9.2.3 Flour homogenization

Pour the break and reduction flour into the blender flask (6.5.3).

Insert the stopper fitted with the worm screw (6.5.2) provided for use with flour into the flask and place the flask on the blender (6.5).

Mix for (20 ± 2) min.

Remove the worm screw (6.5.2) and replace it with the flask stopper. The flour is now ready for the Alveograph test.

9.2.4 Storage of the flour

The flask containing the flour shall be kept in the room where the Alveograph test is performed.

9.3 Expression of milling results

Calculate the extraction rate, ER, as a percentage of dry mass, of flour extracted from the cleaned wheat using Formula (1):

$$ER = \frac{(100 - H_f) \times M_f}{(100 - H_b) \times M_b} \times 100 \quad (1)$$

where

H_f is the moisture content, as a percentage, of the flour obtained (determined in accordance with ISO 712 or ISO 12099);

H_b is the moisture content, as a percentage, of the wheat test portion for milling before moistening (determined in accordance with ISO 712 or ISO 12099);

M_f is the mass, in grams, of the total flour obtained;

M_b is the wheat mass, in grams, of the test portion for milling before moistening.

Express the result to the nearest 0,1 % mass fraction.

Calculate the percentage of bran, S, using Formula (2):

$$S = [M_s / (M_b + M_e)] \times 100 \quad (2)$$

Calculate the percentage of middlings, R, using Formula (3):

$$R = [M_r / (M_b + M_e)] \times 100 \quad (3)$$

where

M_s is the mass, in grams, of bran;

M_r is the mass, in grams, of middlings;

M_b is the initial mass, in grams, of the wheat before conditioning;

M_e is the mass, in grams, of water added (numerically equal to the volume, V_e, in millilitres, of water added).

Express the results to the nearest integer.

NOTE Annex C provides an example of a milling sheet to follow all interesting results.

10 Preparation and Alveograph test

10.1 Preliminary checks

Ensure that the ambient temperature is between 18 °C and 22 °C with a relative humidity between 50 % and 80 %.

Ensure that the various components of the apparatus (kneading machine, Alveograph, burette, tools, etc.) are clean.