INTERNATIONAL STANDARD

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Second edition
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Cereals and pulses — Determination of the mass of 1 000 grains

Céréales et légumineuses — Détermination de la masse de 1 000 grains

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Foreword

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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 520 was prepared by Technical Committee ISO/TC 34, *Food products*, Subcommittee SC 4, *Cereals and pulses*.

This second edition cancels and replaces the first edition (ISO 520:1977), which has been technically revised.

Cereals and pulses — Determination of the mass of 1 000 grains

1 Scope

This International Standard specifies a method for the determination of the mass of 1 000 grains of cereals and pulses.

This International Standard is applicable to all species of cereals and pulses with the exception of seed lots for sowing purposes.

2 Normative references

The following referenced documents are indispensable for the application 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 712, *Cereals and cereal products — Determination of moisture content — Reference method*

ISO 24557, *Pulses — Determination of moisture content — Air-oven method*

3 Terms and definitions

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

3.1
mass of 1 000 grains as received
mass of 1 000 grains including the moisture content at the time of the determination

3.2
mass of 1 000 grains on the dry matter basis
mass of 1 000 grains as received converted to the dry matter basis by correcting for the moisture content at the time of the determination

4 Principle

A test portion is prepared by separating whole grains. The test portion is weighed and the whole grains counted. The mass of the whole grains is divided by their number, and expressed on the basis of 1 000 grains.

5 Apparatus

5.1 Sample divider apparatus (if necessary).

5.2 Appropriate apparatus for counting grains (e.g. a photoelectric counter). If suitable apparatus is not available, counting may be carried out by hand.

5.3 Balance, capable of being read to the nearest 0,001 g.

6 Procedure

6.1 Determination of the mass of 1 000 grains as received

Take by division a mass consisting of approximately 500 grains from the sample as received. Separate the whole grains, weigh them to the nearest 0,01 g and count them. For straw cereals, a mass of 30 g is generally in accordance with this instruction.

Carry out tests in duplicate.

6.2 Determination of the mass of 1 000 grains on the dry matter basis

If the mass of 1 000 grains is to be referred to the dry basis, determine the moisture content of the whole grains free of impurities in a separate sample, in accordance with the reference method specified in ISO 712 for cereals and ISO 24557 for pulses.

7 Expression of results

7.1 The mass of 1 000 grains as received, m_1, in grams, is given by the equation:

$$m_1 = \frac{m_t \times 1\,000}{N}$$

where

m_t is the mass, in grams, of the whole grains in the test portion;

N is the number of whole grains in the test portion.

7.2 The mass of 1 000 grains on the dry matter basis, m_0, in grams, is given by the equation:

$$m_0 = \frac{m_1 \times \left(100 - w_{H_2O}\right)}{100}$$

where

m_1 is the mass, in grams, of the 1 000 grains as received;

w_{H_2O} is the moisture content, expressed as a percentage mass fraction, of the grains as received.

7.3 Take as the result the arithmetic mean of the duplicate tests, provided that the requirement concerning repeatability (see 8.2) is satisfied.

If not, make a new determination and take the average of the test results in the second determination, provided that the requirement concerning repeatability (see 8.2) is satisfied.

Express the result, indicating the mass of 1 000 grains, in grams:

a) to the second decimal place, if the mass is below 10 g;

b) to the first decimal place, if the mass is 10 g or more but does not exceed 100 g;

c) as a whole number, if the mass exceeds 100 g.

8 Precision

8.1 Interlaboratory test

Details of an interlaboratory test on the precision of the method are summarized in Annex A. The values derived from this interlaboratory test cannot be applied to other concentration ranges and matrices than those given.

8.2 Repeatability

The absolute difference between two independent single test results, obtained using the same method on identical test material in the same laboratory by the same operator using the same equipment within a short interval of time, will not in more than 5 % of cases be greater than the repeatability limit

$$r = s_r \times 2{,}77$$

$$r = 0{,}45 \times 2{,}77 = 1{,}3$$

for products whose mass of 1 000 grains on the dry matter basis lies between 29,8 g and 48,2 g (see Tables A.1 and A.2, and Figure A.1).

8.3 Reproducibility

The absolute difference between two single test results, obtained using the same method on identical test material in different laboratories with different operators using different equipment, will not in more than 5 % of cases be greater than the reproducibility limit

$$R = s_R \times 2{,}77$$

$$R = 0{,}82 \times 2{,}77 = 2{,}3$$

for products whose mass of 1 000 grains on the dry matter basis lies between 29,8 g and 48,2 g (see Tables A.1 and A.2, and Figure A.2).

8.4 Comparison of two groups of measurements in one laboratory

Critical difference (CD) is the difference between two averaged values obtained from two test results under repeatability conditions. As the result is a mean of two values (see 7.1), the comparison of mass of 1 000 grains shall be made with critical difference.

The CD between two averaged values obtained from two test results under repeatability conditions is equal to:

$$2{,}8\ s_r\ \sqrt{\frac{1}{2n_1}+\frac{1}{2n_2}}\ = 2{,}8\ s_r\ \sqrt{\frac{1}{2}} = 1{,}98\ s_r\ = 0{,}89 \approx 0{,}9$$

where

s_r is the standard deviation of repeatability;

n_1, n_2 are the number of test results corresponding to each of the averaged values (in the above example $n_1 = n_2 = 2$).

8.5 Comparison of two groups of measurements in two laboratories

The CD between two averaged values obtained in two different laboratories from two test results under repeatability conditions is equal to:

$$2{,}8\ \sqrt{s_R^2 - s_r^2\left(1-\frac{1}{2n_1}-\frac{1}{2n_2}\right)} = 2{,}8\ \sqrt{s_R^2 -\ 0{,}5\ s_r^2}\ = 2{,}12 \approx 2{,}1$$

where

s_r is the standard deviation of repeatability;

s_R is the standard deviation of reproducibility;

n_1, n_2 are the number of test results corresponding to each of the averaged values (in the above example $n_1 = n_2 = 2$).

8.6 Expanded uncertainty

Expanded uncertainty, U, is a parameter representing the distribution of the values which may reasonably be attributed to the result. This uncertainty is given by a statistical distribution of the results from the interlaboratory test and is characterized by the experimental standard deviation.

For mass of 1 000 grains on dry matter basis, the expanded uncertainty is given by

$$U = \pm 2 s_R = \pm 1{,}6$$

where s_R is the reproducibility standard deviation given in 8.3.

9 Note on procedure

9.1 Samples containing decorticated and non-decorticated grains

If the sample contains a mixture of decorticated and non-decorticated grains, the two kinds shall be treated and counted separately.

9.2 Samples containing twin oat grains

Twin oat grains shall be separated from one another and counted as two grains.

10 Test report

The test report shall contain at least the following information:

a) all information necessary for complete identification of the sample;

b) the sampling method used, if known;

c) the test method used, with reference to this International Standard (ISO 520:2010);

d) all operating details not specified in this International Standard, or regarded as optional, together with details of any incidents which may have influenced the test result(s);

e) the test result(s) obtained;

f) details of whether a retest was necessary.

Annex A
(informative)

Results of the interlaboratory test

The repeatability, reproducibility, and critical difference of the method were established by statistical treatment of data obtained during a monthly proficiency test organized by BIPEA (FR) over 10 months. The calculations were performed in accordance with the requirements of ISO 5725-3[1] and ISO 5725-6[2].

Participating laboratories numbered 11 in a test on durum wheat and eight on barley. Of each species, 10 samples were analysed.

The statistical results of the study are presented in Tables A.1 and A.2, and in Figures A.1 and A.2.

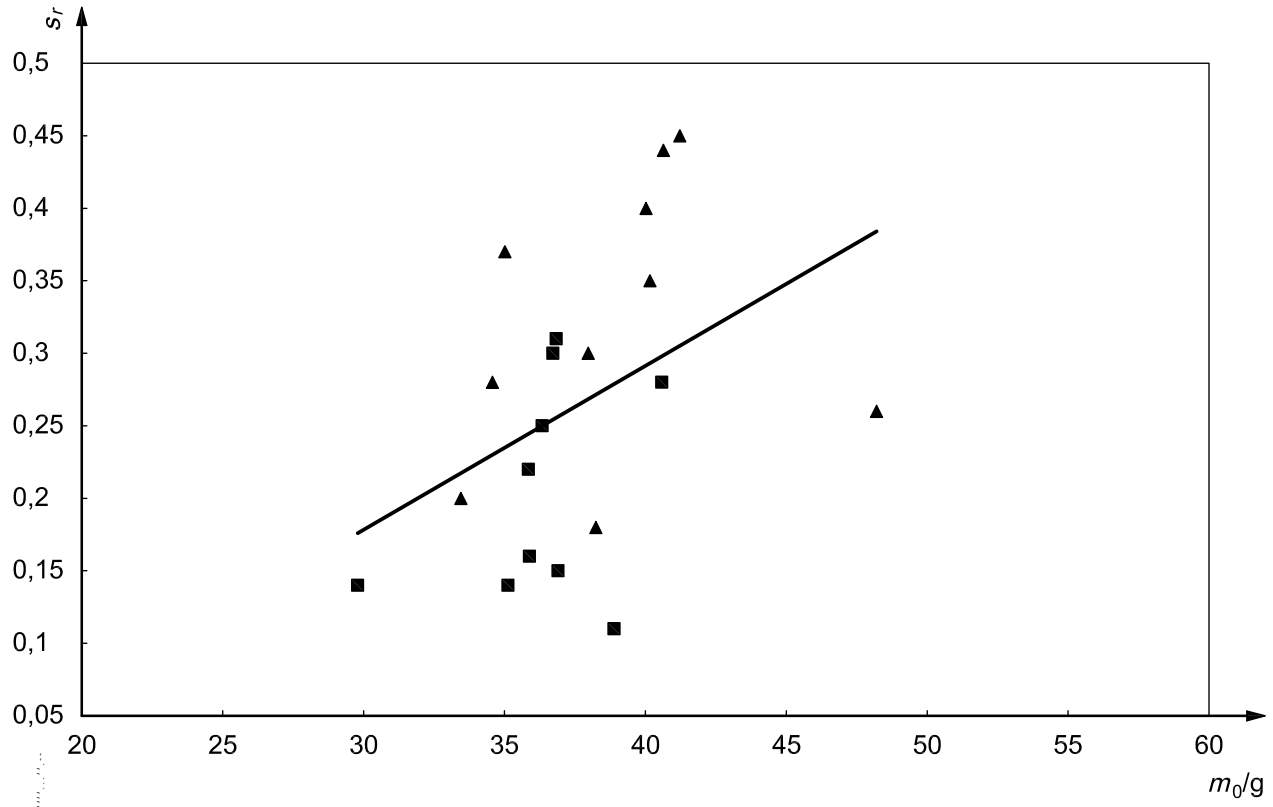
Table A.1 — Statistical results of the inter-laboratory test on durum wheat

Parameters	Durum wheat 1	Durum wheat 2	Durum wheat 3	Durum wheat 4	Durum wheat 5	Durum wheat 6	Durum wheat 7	Durum wheat 8	Durum wheat 9	Durum wheat 10
Number of participating laboratories after eliminating outliers	9	10	12	11	11	11	11	12	11	12
Mean value, $\bar{m}_1$, g	33,45	34,57	35,01	37,97	38,24	40,02	40,16	40,64	41,22	48,20
Repeatability standard deviation, s_r, g	0,20	0,28	0,37	0,30	0,18	0,40	0,35	0,44	0,45	0,26
Coefficient of variation of repeatability, $C_{V,r}$, %	0,60	0,80	1,06	0,78	0,46	0,99	0,87	1,08	1,10	0,53
Repeatability limit, r (2,8 × s_r), g	0,56	0,76	1,01	0,82	0,49	1,10	0,97	1,22	1,26	0,71
Reproducibility standard deviation, s_R, g	0,47	0,75	0,55	0,44	0,34	0,51	0,61	0,48	0,79	0,32
Coefficient of variation of reproducibility, $C_{V,R}$, %	1,40	2,16	1,57	1,16	0,89	1,27	1,53	1,18	1,90	0,67
Reproducibility limit, R (2,8 × s_R), g	1,30	2,07	1,52	1,22	0,94	1,41	1,70	1,33	2,18	0,89

Table A.2 — Statistical results of the inter-laboratory test on barley

Parameters	Barley 1	Barley 2	Barley 3	Barley 4	Barley 5	Barley 6	Barley 7	Barley 8	Barley 9	Barley 10
Number of participating laboratories after eliminating outliers	7	7	8	6	8	8	8	8	7	8
Mean value, $\bar{m}_1$, g	29,79	35,12	35,85	35,89	36,34	36,72	36,84	36,9	38,89	40,58
Repeatability standard deviation, s_r, g	0,14	0,14	0,22	0,16	0,25	0,30	0,31	0,15	0,11	0,28
Coefficient of variation of repeatability, $C_{V,r}$, %	0,47	0,40	0,61	0,43	0,70	0,83	0,85	0,41	0,28	0,68
Repeatability limit, r ($2{,}8 \times s_r$), g	0,39	0,39	0,60	0,43	0,70	0,84	0,87	0,42	0,31	0,77
Reproducibility standard deviation, s_R, g	0,82	0,37	0,69	0,29	0,62	0,50	0,36	0,39	0,41	0,37
Coefficient of variation of reproducibility, $C_{V,R}$, %	2,75	1,05	1,93	0,80	1,71	1,37	0,97	1,04	1,04	0,90
Reproducibility limit, R ($2{,}8 \times s_R$), g	2,27	1,01	1,92	0,80	1,72	1,39	0,99	1,07	1,13	1,01

In order not to have repeatability and reproducibility limits that are too low and thus difficult to meet, the repeatability and reproducibility limits have been retained at the maximum observed values of 1,3 and 2,2, respectively.



Key

s_r repeatability standard deviation

m_0 mass of 1 000 grains on the dry matter basis

$s_r = 0{,}011\ 3m_0 - 0{,}160\ 7$

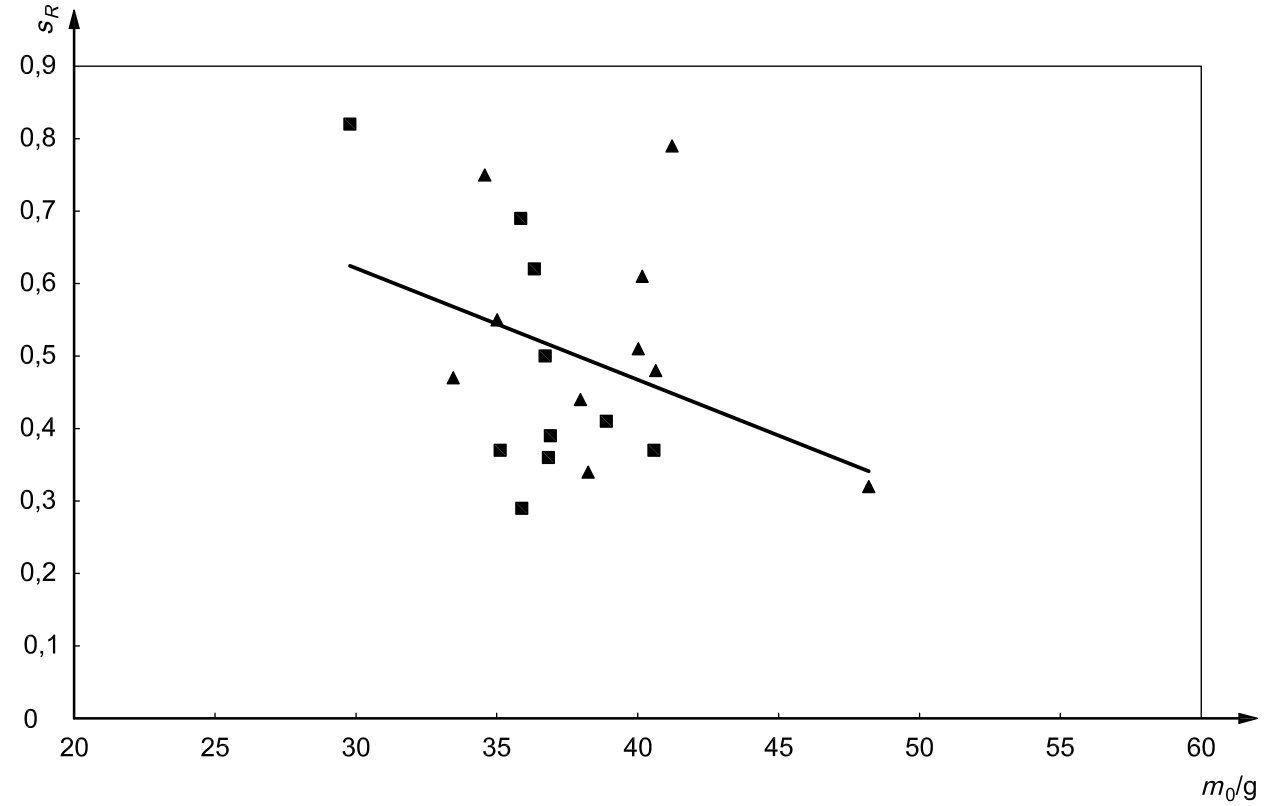
$r^2_{m_0 s_r} = 0{,}171\ 6$

■ individual data for barley

▲ individual data for durum wheat

NOTE As the relationship between the standard deviation of repeatability and the mass of 1 000 grains is not significant ($r^2_{m_0 s_r} = 0{,}171\ 6$ thus $r_{m_0 s_r} = 0{,}414\ 2$ and $r_{m_0 s_r} = 0{,}443\ 8$, the limit value), the limit of repeatability is constant for masses of 1 000 grains between 29,8 g and 48,2 g.

Figure A.1 — Accuracy values for repeatability versus mean values



Key

s_R reproducibility standard deviation

m_0 mass of 1 000 grains on the dry matter basis

$s_R = -0{,}015\,4 m_0 - 1{,}083\,1$

$r^2_{m_0 s_R} = 0{,}128\,4$

■ individual data for barley

▲ individual data for durum wheat

NOTE As the relationship between the standard deviation of reproducibility and the mass of 1 000 grains is not significant ($r^2_{m_0 s_R} = 0{,}128\,4$ thus $r_{m_0 s_R} = 0{,}358\,3$ and $r_{m_0 s_R} < 0{,}443\,8$, the limit value), the limit of reproducibility is constant for masses of 1 000 grains between 29,8 g and 48,2 g.

Figure A.2 — Accuracy values for reproducibility versus mean values

Bibliography

[1] ISO 5725-3:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 3: Intermediate measures of the precision of a standard measurement method*

[2] ISO 5725-6:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 6: Use in practice of accuracy values*

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