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## Maize (*Zea mays* L.) — Specification

*Maïs (Zea mays L.) — Spécifications*

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Published in Switzerland

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 documents 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](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 34, *Food Products*, Subcommittee SC 4, *Cereals and pulses*.

# Maize (*Zea mays* L.) — Specification

## 1 Scope

This document specifies minimum specifications for maize (*Zea mays* L.) intended for human consumption and which is the subject of international trade.

## 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 5223, *Test sieves for cereals*

ISO 6540, *Maize — Determination of moisture content (on milled grains and on whole grains)*

ISO 6639-3, *Cereals and pulses — Determination of hidden insect infestation — Part 3: Reference method*

ISO 6639-4, *Cereals and pulses — Determination of hidden insect infestation — Part 4: Rapid methods*

ISO 7971-1, *Cereals — Determination of bulk density, called mass per hectolitre — Part 1: Reference method*

ISO 7971-3, *Cereals — Determination of bulk density, called mass per hectolitre — Part 3: Routine method*

ISO 24333, *Cereals and cereal products — Sampling*

## 3 Terms and definitions

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

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

— IEC Electropedia: available at <http://www.electropedia.org/>

— ISO Online browsing platform: available at <http://www.iso.org/obp>

### 3.1

#### **bulk density**

#### **test weight**

cereals ratio of the mass of a cereal to the volume it occupies after being poured into a container under well-defined conditions

Note 1 to entry: Bulk density is expressed in kilograms per hectolitre of grains as received. Other units such as grams per litre or pound per bushel could also be used.

### 3.2

#### **impurity**

all matters of a sample of grain other than the basic cereal of unimpaired quality

Note 1 to entry: In maize, impurities comprise four main categories: *broken grains* (3.3), *damaged grains* (3.4), *other grains* (3.5) and *miscellaneous impurities* (3.6).

Note 2 to entry: Live pests are not considered as impurities. They are specified as separate criterion.

[SOURCE: EN 16378:2013, 3.1]

### 3.3

#### **broken grain**

grain or pieces of grain that can pass through a sieve with a circular mesh of 4,5 mm in diameter as specified in ISO 5223

### 3.4

#### **damaged grain**

whole kernel that is distinctly discoloured, sprouted, diseased or damaged by weather, pest, heat, or any other causes and that is not an *unsound grain* (3.6.2) but that is still fit for human and/or animal consumption

#### 3.4.1

##### **heat-damaged grain**

grain with a chestnut to black coloration, resulting from the effect of heat, and of which a section of the endosperm is yellowish-grey or brownish black resulting from the effect of spontaneous heat generation or too extreme heating during drying

#### 3.4.2

##### **sprouted grain**

grain in which the radicle or plumule is clearly visible to the naked eye

Note 1 to entry: Account should be taken of the general appearance of the sample when its content of sprouted grains is assessed.

Note 2 to entry: Sprouted grains are those where the germ has undergone clearly visible changes which makes it easy to distinguish the sprouted grain from the normal grain.

#### 3.4.3

##### **grain attacked by pests**

grain that shows visible damage owing to attack by insects, rodents, mites or other pests

### 3.5

#### **other grain**

grain other than maize, in any condition

### 3.6

#### **miscellaneous impurity**

element that can consist of *extraneous seeds* (3.6.1), *unsound grains* (3.6.2), *extraneous matter* (3.6.3) and *impurities of animal origin* (3.6.4)

#### 3.6.1

##### **extraneous seed**

seed of a plant, whether or not cultivated, other than cereal

Note 1 to entry: "Noxious seeds" means seeds that are toxic to humans and animals, seeds hampering or complicating the cleaning and milling of cereals and seeds affecting the quality of products processed from cereals.

Note 2 to entry: For information on noxious seeds, see [Annex A](#).

#### 3.6.2

##### **unsound grain**

grain rendered unfit for human and/or animal consumption, owing to putrefaction, mildew, grain affected with fusariosis, or bacterial or other causes

Note 1 to entry: Unsound grains also include grains damaged by spontaneous heat generation or too extreme heating during drying which are fully grown grains in which the tegument is coloured greyish-brown to black while the cross-section of the kernel is coloured yellowish grey to brownish-black.

### 3.6.3

#### **extraneous matter**

matter in a sample that can pass through a sieve with apertures of 1,0 mm as specified in ISO 5223, and that also includes stones, sand, fragments of straw, cob and similar impurities in the a sample that are retained by a sieve with apertures of 1,0 mm

### 3.6.4

#### **impurity of animal origin**

matter of animal origin (eggs, larvae, nymphs or adults of insects and their fragments, rodent hairs and their fragments, mites and their fragments) separated from the product under specified conditions

## 4 Specifications

### 4.1 General characteristics and sensory properties

Maize shall be sound, clean and have no foreign odours or odours denoting any deterioration.

### 4.2 Health characteristics

Maize grains shall be free from intentionally added substances and heavy metals in amounts which can represent a hazard to human and/or animal health. Maize shall not contain mycotoxins, pesticides residues or other contaminants at levels (or concentration) which can affect human and/or animal health. The maximum levels authorized are laid down by the national or regional regulation, or the joint FAO/WHO Codex Alimentarius Commission (see References [4] to [7]).

Maize shall be free from the living insects (listed in [Annex B](#)), when determined according to ISO 6639-3 or ISO 6639-4, and of mites, when determined by the sieving method, which are clearly visible to the naked eye.

### 4.3 Physical and chemical characteristics

#### 4.3.1 Moisture content

The moisture content of maize, determined in accordance with ISO 6540, shall not be greater than 14,5 % (mass fraction).

NOTE Different moisture contents are required for certain destinations, in relation to the climate, and duration of transport and storage. For further information, see ISO 6322-1, ISO 6322-2 and ISO 6322-3.

#### 4.3.2 Bulk density

The bulk density, called "mass per hectolitre", of maize shall be determined using instruments calibrated according to the reference method given in ISO 7971-1 or, by default, according to the routine method given in ISO 7971-3, and shall not be less than 60 kg/hl.

#### 4.3.3 Impurities

The maximum impurities content, determined using the method described in [Annexes C](#) and [D](#), shall not exceed the value given in [Table 1](#).

The maximum content of the impurities (broken grains, damaged grains, other grains and miscellaneous impurities), shall not exceed 15 % (mass fraction) in total.

Table 1 — Maximum levels of impurities

Impurities	Definition given in	Maximum permissible level % (mass fraction)
Broken grains	<a href="#">3.3</a>	6,0
Damaged grains	<a href="#">3.4</a>	10,0
Miscellaneous impurities	<a href="#">3.6</a>	1,0
Extraneous matter	<a href="#">3.6.3</a>	1,0
Impurities of animal origin	<a href="#">3.6.4</a>	0,1

NOTE The maximum content of the impurities (broken grains, damaged grains, other cereals and miscellaneous impurities), shall not exceed 15 % (mass fraction) in total.

## 5 Sampling

Sampling shall be carried out in accordance with ISO 24333.

## 6 Test methods

The test methods shall be carried out using the methods specified in [4.3](#), [Annexes C](#) and [D](#).

## 7 Transportation

Maize shall be transported in a manner that is free of living pests. It shall be protected from water and from being contaminated by toxic or harmful substances.

## Annex A (informative)

### Indicative list of noxious seeds

**WARNING — This is a non-exhaustive list which could be completed if the necessity arose.**

#### A.1 Toxic seeds

##### Botanical name

##### Common name

*Acroptilon repens* (L.) DC.

*Agrostemma githago* L.

*Coronilla varia* L.

*Crotalaria* spp.

*Datura fastuosa* L.

*Datura stramonium* L.

*Heliotropium lasiocarpum* Fisher et C.A.

*Lolium temulentum* L.

*Ricinus communis* L.

*Sophora alopecuroides* L.

*Sophora pachycarpa* Schrank ex C.A. Meyer

*Thermopsis montana*

*Thermopsis lanceolata* R. Br. in Aiton

*Trichoderma incarnum*

Corn-cockle

Coronilla, Crown vetch

Crotalaria

Jimson weed

Stramony, thorn apple

Meyer Heliotrope

Darnel

Castor-oil plant

Stagger bush, Russian centaury

Buffalo pen

#### A.2 Harmful seeds

##### Botanical name

##### Common name

*Allium sativum* L.

*Cephalaria syriaca* (L.)

*Melampyrum arvense* L.

*Melilotus* spp.

*Sorghum halepense* (L.)

*Trogonella foenum-graecum* L.

Garlic

Roemer et Shultes Teasel

Cow-cockle

Melilot

Pers. Johnson grass

Fenugreek

## Annex B (normative)

### Unacceptable mites and insect pests of stored cereals

The following are unacceptable in stored cereals:

- *Ahasverus advena* (Waltl);
- *Attagenus brunneus* (Faldermann);
- *Attagenus unicolor japonicus* (Reitter);
- *Corcyra cephalonica* (Stainton);
- *Cryptolestes ferrugineus* (Stephens);
- *Cryptolestes pusillus* (Schönherr);
- *Cryptolestes turcicus* (Grouville);
- *Ephestia cautella* (Walker);
- *Ephestia kiihniella* (Zeller);
- *Latheticus oryzae* (Waterhouse);
- *Liposcelis bostrychophila* (Badonnel);
- *Nemapogon granella* (L.);
- *Oryzaephilus mercator* (Fauvel);
- *Oryzaephilus surinamensis* (Linnaeus);
- *Plodia interpunctella* (Hübner);
- *Prostephanus trurtcatus* (Hom);
- *Rhizopertha dominica* (Fabricius);
- *Sitotroga cerealella* (Olivier);
- *Sitophilus granarius* (Linnaeus);
- *Sitophilus oryzae* (Linnaeus);
- *Sitophilus zeamais* (Motschulsky);
- *Tenebroides mauritanicus* (Linnaeus);
- *Tribolium castaneum* (Herbst);
- *Tribolium confusum* (Jacquelin du Val);
- *Trogoderma granarium* (Everts);
- *Trogoderma variabile* (Ballion);
- *Tyroglyphus ovatus* (Troupeau);

— *Tyrophagus putrescentiae* (Schrank).

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## Annex C (normative)

### Determination of impurities

#### C.1 Principle

The principle of this method is to separate all the groups of impurities, as defined in [Clause 3](#), from the normal basic grains by sieving and manual selection.

#### C.2 Apparatus and equipment

**C.2.1 Sample divider.**

**C.2.2 Balance,** with a reading accuracy of 0,001 g and capable of weighing to the nearest 0,01 g.

**C.2.3 Sieves,** with round apertures of diameter 4,5 mm and slot-widths 1,0 mm × 20,0 mm, in accordance with the specifications of ISO 5223.

**C.2.4 Sieving machine,** having a rectilinear movement of go and come in the sense of the rectangular holes.

**C.2.5 Magnifying glass,** illuminated.

**C.2.6 Forceps or horn spatula.**

**C.2.7 Pots,** for retaining components.

**C.2.8 Colour standard,** as reference S 3030-Y30R in the Natural Colour System (NCS<sup>1)</sup>).

NOTE The Natural Colour System is defined by the Scandinavian Colour Institute AB, Stockholm (SE). For further explanation see <http://hcscolour.com/>.

#### C.3 Sampling

It is important that the laboratory receives a sample that is truly representative and has not been damaged or changed during transport and storage.

Sampling is not part of the method specified in this document. For information, a recommended sampling procedure is given in ISO 24333 for the sampling of cereals with constituents distributed uniformly or not uniformly.

#### C.4 Procedure

Prepare by division a representative sample of at least (but near) 500 g for maize. Weigh it to the nearest 0,1 g (a). Pass the sample through the slotted sieve with an aperture of 1,0 mm ([C.2.3](#)), for half a minute.

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1) This information is given for the convenience of users of this document and does not constitute an endorsement by ISO.

For constant sieving, a sieving machine (C.2.4) is recommended. If sieving is performed by hand, it shall consist of horizontal movements parallel to the length of the slots.

The matter passed through the 1,0 mm sieve shall be regarded as extraneous matter. Stones, mud balls, straws, chaff, cob fragments and similar impurities from the overtail of the 1,0 mm slotted sieve have to be picked out. Both fractions are combined and are regarded as extraneous matter. Weigh them to the nearest 0,1 g (b). Impurities of animal origin should be counted (n), including those which passed through the sieve of 1,0 mm slot-width (C.2.3). If necessary, a magnifying glass should be used.

The count of impurities of animal origin should be quoted separately in numbers per kilogram of maize, as appropriate.

From the over tails of the 1,0 mm sieve (C.2.3), prepare, with the aid of a sample divider, a test sample, between 100 g and 200 g. Weigh this test sample to the nearest 0,01 g (c).

Subsequently spread out this partial sample in a thin layer on a table, and pick out by means of forceps or a horn spatula the element constituting the groups of impurities: other cereals, damaged grains, and miscellaneous impurities.

Grains whose tegument shows abnormal colour shall be cut longitudinally through the germ. If a major part or the totality of the section of the germ is identical or darker than the colour standard, then the two halves of the initial grain have to be accounted as heat-damaged grains.

In the case of multiple kinds of damages are observed, the damaged grain shall be added to the fraction with the highest importance for the overall quality.

Subsequently sieve the same partial sample through a sieve of 4,5 mm circular holes in diameter for half a minute. The through of this sieve belong to the group broken grains.

Weigh the clean sample material (d) and all the groups of impurities to the nearest 0,01 g. If, for a partial sample, the sum of weights for broken grains, damaged grains, heat-damaged grains, other cereals, extraneous seeds, extraneous matters and the weight of the impurities-free overtails of the 1,0 mm sieve (d) differs by more than 1 % from (c), the determination shall be invalid and a new partial sample shall be analysed.

## C.5 Expression of results

The mass fraction in percent of the impurity fractions are calculated as shown by [Formula \(C.1\)](#):

$$w_B = m_x \times \frac{m_a - m_b}{m_c} \times \frac{100}{m_a} \quad (\text{C.1})$$

where

$w_B$  is the mass fraction of impurity fractions (%);

$m_x$  is the mass of the impurity group concerned (g);

$m_a$  is the mass of the average sample (g);

$m_b$  is the mass of the extraneous matter on average sample (g);

$m_c$  is the mass of subsample from which impurity will be removed (g).

The mass fraction in percent of extraneous matter is calculated as shown by [Formula \(C.2\)](#):

$$w_A = \left[ \left( m_x \times \frac{m_a - m_b}{m_c} \right) + m_b \right] \times \frac{100}{m_a} \quad (\text{C.2})$$

where

$w_A$  is the percentage of extraneous matter (%);

$m_{x8}$  is the mass of extraneous matter of subsample from which impurity was removed (g);

$m_a$  is the mass of the average sample (g);

$m_b$  is the mass of the extraneous matter of average sample (g);

$m_c$  is the mass of subsample from which impurity will be removed (g).

The percentage of damaged grains is calculated by adding percentages of heat-damaged grains, sprouted grains, and grains attacked by pests.

The percentage of miscellaneous impurities is calculated by adding percentages of extraneous seeds, unsound grains and extraneous matters.

The calculation should be carried out to the nearest 0,01 %.

In the investigation report, quote to a precision of 0,1 % for total impurities, broken grains, damaged grains, other cereals and miscellaneous impurities and to a precision of 0,01 % for all sub components of these categories. Report the impurities of animal origin in number per kilogram of grain.

## C.6 Precision

### C.6.1 General

Details of an international inter-laboratory test on the precision of the method are summarized in EN 16378:2013 Annex D.

The values derived from this test may not be applicable to concentration ranges and matrices other than those given:

- 0,0 % to 2,7 % for broken grain;
- 0,2 % to 3,5 % for damaged grain and other grain;
- 0,5 % to 3,3 % for miscellaneous impurity;
- 1,8 % to 8,7 % for total impurity.

The formulae in C.6.2 to C.6.4 have been elaborated using the data of the inter-laboratory test.

Because of a too tight range for sprouted grain in the inter-laboratory test, it has not been possible to determine fidelity values for this class of impurities.

### C.6.2 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  $r$ .

Broken grain:  $r = 2,8 \times [(0,059 \times w_{B, \text{broken grain}}) + 0,036]$

Damaged grain and other grain:  $r = 2,8 \times [(0,242 \times w_{B, \text{damaged grain and other grain}}) + 0,074]$

Miscellaneous impurity:  $r = 2,8 \times [(0,107 \times w_{B, \text{miscellaneous impurity}}) + 0,119]$

Total impurity:  $r = 2,8 \times [(0,087 \times w_{B, \text{total impurity}}) + 0,176]$

### C.6.3 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  $R$ .

$$\text{Broken grain: } R = 2,8 \times [(0,252 \times w_{B,\text{broken grain}}) + 0,015]$$

$$\text{Damaged grain and other grain: } R = 2,8 \times [(0,618 \times w_{B,\text{damaged grain and other grain}}) + 0,228]$$

$$\text{Miscellaneous impurity: } R = 2,8 \times [(0,437 \times w_{B,\text{miscellaneous impurity}}) + 0,077]$$

$$\text{Total impurity: } R = 2,8 \times [(0,478 \times w_{B,\text{total impurity}}) - 0,058]$$

### C.6.4 Uncertainty

Uncertainty ( $U_e$ ) 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 every parameter, the uncertainty is equal to plus or minus twice the reproducibility standard deviation given in EN 16378:2013 Annex D.

$$\text{Broken grain: } U_e = 2 \times [(0,252 \times w_{B,\text{broken grain}}) + 0,015]$$

$$\text{Damaged grain and other grain: } U_e = 2 \times [(0,618 \times w_{B,\text{damaged grain and other grain}}) + 0,228]$$

$$\text{Miscellaneous impurity: } U_e = 2 \times [(0,437 \times w_{B,\text{miscellaneous impurity}}) + 0,077]$$

$$\text{Total impurity: } U_e = 2 \times [(0,478 \times w_{B,\text{total impurity}}) - 0,058]$$

### C.7 Test report

The test report shall specify the following:

- a) all information necessary for the complete identification of the sample;
- b) the sampling method used, if known;
- c) the test method used, together with the reference to this document, i.e. ISO 19942;
- d) all operating details not specified in this document, or regarded as optional, together with details of any incidents which may have influenced the test results;
- e) the test results obtained, and, if the repeatability has been checked, the final quoted result obtained.

EXAMPLE The test results obtained can be reported as follows:

- a) bulk density: XX kg/hl or XX g/l or lb/bu;

NOTE Results are sometimes expressed in lb/bu (pound/bushel).

- b) broken grains: X,X %;
- c) damaged grains: X,X %:
  - 1) heat damaged grains : X,XX %;
  - 2) sprouted grains: X,XX %;
  - 3) grains attacked by pests: X,XX %;

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- d) other cereals: X,X %;
- e) miscellaneous impurities: X,X %:
  - 1) extraneous seeds: X,XX %;
  - 2) unsound grains: X,XX %;
  - 3) extraneous matter: X,XX %;
  - 4) impurities of animals origin: number/kg;
- f) total impurities X,X %.

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