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PEARL MILLET GRAINS – SPECIFICATION

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Pearl millet grains — Specification



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Introduction

Of all the world's cereals, pearl millet (*Pennisetum glaucum*) is the sixth most important. It is a staple food in many African countries as well as India. Today, pearl millet is planted on some 14 million hectares in Africa and 14 million hectares in Asia. Global production of its grain probably exceeds 10 million tons a year, to which India contributes nearly half. At least 500 million people depend on pearl millet for their lives.

Pearl millet is supremely adapted to heat and aridity and, for all its current decline, seems likely to spring back as the world gets hotter and drier. Perhaps the best of all "life-support" grains, pearl millet thrives where habitats are harsh. Of all the major cereals, it is the one most able to tolerate extremes of heat and drought. It yields reliably in regions too hot and too dry to consistently support good yields of maize (or even sorghum). These happen to be the regions most desperately in need of help.

Pearl millet is easy to grow. It suffers less from diseases than sorghum, maize, or other grains. Also, it has fewer insect pests.

The widespread impression that pearl millet grain is essentially an animal feed, unpalatable to all but the desperately hungry, is wrong. The grain is actually a superior foodstuff, containing at least 9 percent protein and a good balance of amino acids. It has more oil than maize and is a "high-energy" cereal. It has neither the tannins nor the other compounds that reduce digestibility in sorghum.

Pearl millet is also a versatile foodstuff. It is used mainly as a whole, cracked, or ground flour; a dough; or a grain like rice. These are made into unfermented breads (*roti*), fermented foods (*kisra* and *gallettes*), thin and thick porridges (*toh*), steam-cooked dishes (*couscous*); nonalcoholic beverages, and snacks.

Grain from certain cultivars is roasted whole and consumed directly. The staple food of the mountainous regions in Niger is millet flour mixed with dried dates and dried goat cheese. This nutritious mixture is taken on long journeys across the Sahara and eaten mixed with water—no cooking required.

This African Standard is a technical revision of the earlier ARS 463:1987(E), *Standard for pearl millet grains* which is hereby superseded and cancelled.

ENQUÊTE PUBLIQUE N° 19

Pearl millet grains — Specification

1 Scope

This African Standard specifies the requirements, methods of sampling and test for whole and decorticated pearl millet grains of the species *Pennisetum glaucum* (L.) R.Br. intended for human consumption.

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.

ARS 53, *General principles of food hygiene — Code of practice*

ARS 56, *Prepackaged foods — Labelling*

AOAC Official Method 2001.04, *Determination of Fumonisin B₁ and B₂ in corn and corn flakes — Liquid chromatography with immunoaffinity column cleanup*

CODEX STAN 193, *Codex general standard for contaminants and toxins in food and feed*

ISO 520, *Cereals and pulses — Determination of the mass of 1000 grains*

ISO 605, *Pulses — Determination of impurities, size, foreign odours, insects, and species and variety — Test methods*

ISO 711, *Cereals and cereal products — Determination of moisture content (Basic reference method)*

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

ISO 5498, *Agricultural food products — Determination crude fibre content — General method*

ISO 5984, *Animal feeding stuffs — Determination of crude ash*

ISO 6561-1, *Fruits, vegetables and derived products — Determination of cadmium content — Part 1: Method using graphite furnace atomic absorption spectrometry*

ISO 6561-2, *Fruits, vegetables and derived products — Determination of cadmium content — Part 2: Method using flame atomic absorption spectrometry*

ISO 6579, *Microbiology of food and animal feeding stuffs — Horizontal method for the detection of Salmonella spp.*

ISO 6633, *Fruits, vegetables and derived products — Determination of lead content — Flameless atomic absorption spectrometric method*

ISO 6637, *Fruits, vegetables and derived products — Determination of mercury content — Flameless atomic absorption method*

ISO 6888-1, *Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of coagulase-positive staphylococci (Staphylococcus aureus and other species) — Part 1: Technique using Baird-Parker agar medium*

ISO 6888-2, *Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of coagulase-positive staphylococci (Staphylococcus aureus and other species) — Part 2: Technique using rabbit plasma fibrinogen agar medium*

ISO 6888-3, *Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of coagulase-positive staphylococci (Staphylococcus aureus and other species) — Part 3: Detection and MPN technique for low numbers*

ISO 7251, *Microbiology of food and animal feeding stuffs — Horizontal method for the detection and enumeration of presumptive Escherichia coli — Most probable number technique*

ISO 7971, *Cereals — Determination of bulk density, called mass per hectolitre — Part 2: Method of traceability for measuring instruments through reference to the international standard instrument*

ISO 9648, *Sorghum — Determination of tannin*

ISO 11085, *Cereals, cereals-based products and animal feeding stuffs — Determination of crude fat and total fat content by the Randall extraction method*

ISO 16050, *Foodstuffs — Determination of aflatoxin B₁, and the total content of aflatoxin B₁, B₂, G₁ and G₂ in cereals, nuts and derived products — High performance liquid chromatographic method*

ISO 20483, *Cereals and pulses — Determination of the nitrogen content and calculation of the crude protein content — Kjeldahl method*

ISO 21527-2, *Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of yeasts and moulds — Part 2: Colony count technique in products with water activity less than or equal to 0.95*

ISO 24333, *Cereals and cereal products — Sampling*

ISO 27085, *Animal feeding stuffs — Determination of calcium, sodium, phosphorus, magnesium, potassium, iron, zinc, copper, manganese, cobalt, molybdenum, arsenic, lead and cadmium by ICP-AES*

3 Terms and definitions

For the purpose of this standard the following terms and definitions shall apply.

3.1

pearl millet grain

the whole or decorticated grain of the species *Pennisetum glaucum* (L.) R.Br.

3.2

whole grains

grains of pearl millet obtained after proper threshing

3.3

decorticated grains

grains of pearl millet from which the outer parts have been removed in an appropriate manner using mechanical treatment (for example abrasion).

3.4

foreign matter

foreign matter is mineral or organic matter (dust, twigs, seed coats, seeds of other species, dead insects, fragments, or remains of insects, other impurities of animal origin)

3.5

other edible grains

any edible grains (including oil seeds) other than the one which is under consideration

3.6**damaged grains**

kernels, pieces of sorghum kernels, and other grains that are badly ground damaged, badly weather damaged, diseased, frost-damaged, germ-damaged, heat-damaged, insect-bored, mould-damaged, sprout-damaged, or otherwise materially damaged.

3.7**immature and shrivelled grains**

grains that are not properly developed

3.8**weevilled grains**

grains that are partially or wholly bored by insects injurious to grains but does not include germ eaten grains and egg spotted grains

3.9**poisonous, toxic and/or harmful seeds**

any seed which if present in quantities above permissible limit may have damaging or dangerous effect on health, organoleptic properties or technological performance such as Jimson weed — *Datura* (*D. fastuosa* Linn and *D. stramonium* Linn.) corn cokle (*Agrostemma githago* L., *Machai Lallium remulenum* Linn.) Akra (*Vicia* species), *Argemone mexicana*, Khesari and other seeds that are commonly recognized as harmful to health

3.10**food grade packages**

packages which safeguard the hygienic, nutritional, technological and organoleptic qualities of the product

4 Quality requirements**4.1 General requirements**

4.1.1 Pearl millet shall meet the following general requirements:-

- a) the dried mature grains of *Pennisetum (glaucum) americanum* Linn;
- b) clean, wholesome, uniform in size and colour.
- c) safe and suitable for human consumption;
- d) free from abnormal flavours, obnoxious smell and discolouration.

4.2 Specific requirements

Pearl millet may be graded into three grades on the basis of the tolerable limits established in Table 1 which shall be additional to the general requirements set out in this standard.

Table 1 — Specific requirements for pearl millet grains

No.	Characteristic		Grade			Method of test
			1	2	3	
1	Foreign matter, whole grains, % m/m, <i>max.</i>	Organic	0.25	0.50	0.75	ISO 605
		Inorganic	0.10	0.25	0.25	
2	Foreign matter, decorticated, % m/m, <i>max.</i>		0.5			
3	Total foreign matter, whole grains		≤2%.			
4	Other edible grains, % m/m, <i>max.</i>		2.0	2.5	3.0	
5	Damaged grain, % m/m, <i>max.</i>		1.0	2.0	4.0	
6	Immature and shrivelled, % m/m, <i>max.</i>		3.0	5.0	8.0	
7	Weevilled grains, % by count, <i>max</i>		2.5	4.0	6.0	
8	Moisture content, % m/m, <i>max</i>		13.5	13.5	13.5	ISO 711/712
9	Crude protein, % by dry mass basis, min (N×6.25)		8.0			ISO 20483
10	Ergot affected grains, %m/m, <i>max</i>		0.05			Annex A
11	Fat content, % by dry mass basis					
12	whole millet grains		3.5 to 6.0			ISO 11085
13	decorticated millet grains		2.0 to 4.0			ISO 11085
14	Total ash (decorticated) % by dry mass, <i>max</i>		1.0			ISO 5984
15	Tannin content, % by mass, <i>max.</i>		0.5			ISO 9648
16	1000 Kernel weight, g					
17	Whole millet grains		5.0 to 10.0			ISO 520
18	Decorticated millet grains		4.0 to 8.0			ISO 520
19	1 litre weight, g		750 to 820			ISO 7971
20	Decortication %m/m <i>max</i>		20			ISO 605
21	Crude fibre, % by dry mass basis:					
22	whole millet grains		3.0 to 4.5			ISO 5498
23	decorticated millet grains %m/m <i>max</i>		2.0			
24	Total Aflatoxin (AFB ₁ +AFB ₂ +AFG ₁ +AFG ₂)), ppb <i>max</i>		10			ISO 16050
25	Aflatoxin B ₁ only, ppb <i>max</i>		5			
26	Fumonisin, ppm <i>max</i>		2			AOAC 2001.04

NOTE **Foreign matter** is mineral or organic matter (dust, twigs, seed coats, seeds of other species, dead insects, fragments, or remains of insects, other impurities of animal origin). Pearl millet grains shall have not more than 1% extraneous matter of which not more than 0.25% shall be mineral matter and not more than 0.10% shall be dead insects, fragments or remains of insects, and/or other impurities of animal origin.

5 Contaminants

5.1 Metals contaminants

Pearl millet grains shall comply with those maximum limits for metal contaminants specified in CODEX STAN 193 and in particular those listed in Table 2.

Table 2 — Metal contaminants

S/N	Parameter	Limit (ppm max)	Test method
(1)	Arsenic (As)	0.1	ISO 27085
(3)	Lead (Pb)	0.1	ISO 6633
(4)	Cadmium (Cd)	0.02	ISO 6561-1 or ISO 6561-2

5.2 Pesticide residues

Pearl millet grains shall comply with those maximum pesticide residue limits established by the Codex Alimentarius Commission for this commodity.

6 Hygiene

6.1 Pearl millet shall be produced, prepared and handled in accordance with the provisions of appropriate sections of ARS 53.

6.2 When tested by appropriate methods in the standards listed in Clause 2, the products:

- shall be free from microorganisms in amounts which may present a hazard to health and shall not exceed the limits stipulated in Table 3;
- shall not contain any substance originating from microorganisms in amounts which may present a hazard to health.

Table 3 — Microbiological limits

	Type of micro-organism	Limits	Test method
(1)	Yeasts and moulds, cfu per g, max	10^4	ISO 21527-2
(2)	<i>Staphylococcus aureus</i> , cfu per 25 g, max	10^3	ISO 6888
(3)	<i>E. coli</i> , max. per g	Absent	ISO 7251
(4)	<i>Salmonella</i> , max. per 25 g	Absent	ISO 6579

7 Packaging

7.1 Pearl millet grains shall be packed in food grade packages which shall be clean, sound, free from insect, fungal infestation.

7.3 Each package shall contain pearl millet grains of the same type and of the same grade designation.

7.4 If pearl millet grains are presented in bags, the bags shall also be free of pests and contaminants.

8 Marking or labelling

8.1 In addition to the requirements in ARS 56, each package shall be legibly and indelibly marked with the following:

- i) product name as "Whole Pearl Millet Grains" or "Decorticated Pearl Millet Grains;
- ii) variety;
- iii) grade;
- iv) name, address and physical location of the producer/ packer/importer;
- v) lot/batch/code number;
- vi) net weight, metric unit;
- vii) the declaration "Food for Human Consumption";

- viii) storage instruction as “Store in a cool dry place away from any contaminants”;
- ix) crop year;
- x) packing date;
- xi) instructions on disposal of used package;
- xii) country of origin;
- xiii) a declaration on whether the pearl millet was genetically modified or not.

9 Sampling

Sampling shall be done in accordance with the ISO 24333.

Annex A (normative)

Determination of ergot

A.1 Test for presence of ergot in food grains

A.1.1 Reagents

- (a) **Petroleum ether** — 40 – 60 °C
- (b) **Solvent ether**
- (c) **Dilute Ammonia** 10 % (v/ v)
- (d) **Tartaric acid solution** — 1 % (freshly prepared)
- (e) **p-dimethyl amino benzaldehyde (PDAB)** — Dissolve 0.125 gm of PDAB in a cold mixture of 65 ml of conc sulphuric acid and 35 ml of distilled water.

Add 0.1 ml of 5 % Ferric chloride solution and let it stand for 24 hours before use.

A.1.2 Apparatus

- (a) Grinding mill
- (b) Electric shaker

A.1.3 Procedure

Grind about 50 gm of sample in the grinding mill to a fine powder. Take 10 gm of powdered sample in a stoppered conical flask. Add sufficient petroleum ether and shake for half an hour in the electric shaker. Allow to settle and decant off the petroleum ether. Dry the material in air. Add to the material 8 ml of dilute ammonia and sufficient quantity of solvent ether. Again shake for ½ hour. Filter ether portion in a beaker and concentrate to a small volume. Add 2 ml of tartaric acid solution to the beaker and shake thoroughly. Mix 1 ml of this tartaric acid – sample solution with 1 or 2 ml of p-dimethyl benzaldehyde solution.

The appearance of blue colour indicates presence of ergot.

A.2 Determination of quantity of ergot (*Claviceps purpurea* Tul.)

A.2.1 Objective and field of application

The method is used for both qualitative and quantitative determination of ergot in food and feed. The method is suitable for the examination of food and feed of different particle sizes. In pelleted feedingstuff only qualitative determination is possible.

A.2.2 Principle

Ergot in food and feed is determined by the macroscopic and microscopic identification of the ergot sclerotia and fragments. Quantification is done by weighing the amount of identified sclerotia and fragments with a particle size >0.5 mm.

A.2.3 Reagents

A.2.3.1 Chloral hydrate, β = 60%

A.2.3.2 Sodium hydroxide (pelleted)

A.2.3.3 Potassium hydroxide (pelleted)

A.2.3.4 Ethanol, $\sigma = 50\%$

A.2.3.5 Acetone

The reagents listed can be replaced by others which produce comparable results.

A.2.4 Equipment and accessories

A.2.4.1 Optical equipment

A.2.4.1.1 Stereo microscope (up to 70x magnification)

A.2.4.1.2 Magnifier (up to 10x magnification)

A.2.4.2 Mortar and pestle

A.2.4.3 Sieves fitted with wire nettings or perforations with different mesh sizes (e.g. 2.0 mm, 1.0 mm, 0.5 mm, 0.25 mm) and collecting tray; recommended additional equipment: sieve towers, sieve shaker

A.2.4.4 Analytical balance (accuracy 0.001 g)

A.2.4.5 Oven (up to 130 °C)

A.2.4.6 Laboratory glassware

A.2.4.7 Filters (e.g. paper, gaze)

A.2.4.8 Freeze dryer

A.2.4.9 Hot plate or Bunsen burner

A.2.4.10 Reference material

A.2.5 Procedure

The examination is performed in non-pelleted food and feed. Pelleted food and feed have to be depelleted before examination (A.2.4.2; A.2.8.1).

Qualitative determination of the sclerotia is performed macroscopically and microscopically considering ergot and its fragments in both the sieve fraction $>0.5\text{mm}$ and $< 0.5\text{mm}$.

Quantification is performed by selecting and weighing of ergot and its fragments with a particle size $>0.5\text{mm}$ out of the laboratory sample or an aliquot of it.

A.2.5.1 Preparation of the laboratory sample

A.2.5.1.1 Whole kernel feedstuff (at least 250g) are weighed (A.2.4.4) and used directly for the investigation (A.2.5.2 and A.2.5.3).

A.2.5.1.2 Non-pelleted feedstuff (at least 10g) are weighed (A.2.4.4) and fractionated by sieving. The obtained fractions $> 0.5\text{mm}$ and $\leq 0.5\text{mm}$ are weighed (A.2.4.4).

A.2.5.2 Identification of ergot

Ergot sclerotia are identified based on their characteristic features. The identification may be facilitated by comparison to reference material (A.2.4.10) and existing descriptions.

Morphology: *Ergot sclerotia* Tul. are elongated with a length up to several centimetres, coloured dark violet to black. The shape is similar to cereal kernels. They only consist of fungal hyphae.

Anatomy: Cross sections through the random parts of ergot sclerotia show very small, narrow interconnected hyphae which yield a dense pseudoparenchymatic tissue. The cells contain lots of fat oil. The outer layers of the hyphae are coloured dark violet to black, whereas the inner parts are coloured light pink to violet.

For the identification of ergot fragments in the sieve fractions <0.5mm the following colour reaction can be used. This staining procedure is only applicable to fresh sclerotia material.

A filter paper is soaked with a solution of 3ml ethanol (A.2.3.4) and 2 sodium hydroxide pellets (A.2.3.2) or 2 potassium hydroxide pellets (A.2.3.3). The sample is distributed on the filter paper.

After app. 5 min. a red-violet halo around the ergot fragments is observed.

The dark violet colouring of the outer hyphae layers is dissolved also in chloralhydrate (A.2.3.1) and colours it violet.

A.2.5.3 Quantification

The quantification of ergot is performed using the sieve fractions > 0.5 mm.

Material identified as ergot in each fraction is selected and weighed. An aliquot of the sieved fractions may be used if necessary. The ergot content of the fractions >0.5mm is summarized and expressed in mg/kg feedstuff (A.2.6.1).

A.2.6 Calculation and report

A.2.6.1 Calculation

The amount of ergot fragments in mg/kg (ppm) feedstuff (original sample) is calculated using the following formula:

$$C = \frac{BC \times 1000}{E} \text{ [mg/kg]}$$

C = amount of component in mg/kg feedstuff (ppm)

BC = selected fragments of component in the laboratory sample or an aliquot of it [mg]

E = total weight of the laboratory sample or an examined aliquot of the laboratory sample [g]

A.2.6.2 Report

A.2.6.2.1 Negative result:

As far as was discernible using a microscope, ergot was not found in the submitted sample.

A.2.6.2.2 Positive result:

As far as was discernible using a microscope xx mg ergot/kg feedstuff were found in the submitted sample. For quantification ergot particles >0.5 mm are considered.

A.2.6.2.3 Possible adding to the report:

ARS 463:2016(E)

In pelleted feedstuff only qualitative determination of ergot is possible.

A.2.8 Remarks

A.2.8.1 For the identification of ergot in pelleted feedstuffs, the sample is depleted using either of the following procedures:

- (a) At least 10 g of the pressed material is mixed with at least three times as much water. The suspension is stirred up several times and left standing until the pellets disintegrate. Then the depelletised material is filtered (A.2.4.7) and dried at room temperature or freeze-dried (A.2.4.8).
- (b) For depelletising at high humidity pressed material (at least 10 g) is left standing in humid atmosphere at 70 °C (A.2.4.5) until the pellets disintegrate. The material is crushed, sieved (A.2.4.3) and dried at room temperature immediately to prevent the particles from sticking together again.

A.2.8.2 Ergot are the permanent forms or sclerotia of ergot which mainly occur in rye, more seldom in wheat, triticale and barley.

A.2.8.3 This method also is suitable for the examination of raw material and food.

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EAS 284:2012, *Pearl millet grains — Specification*

CODEX STAN 169:1987 (Rev.1:1995), *Whole and decorticated pearl millet grains*

CODEX STAN 228:2001 (Rev.1:2004), *General methods of analysis for contaminants*

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