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SORGHUM GRAINS – SPECIFICATION

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B.P.: 14966 Yaoundé – CAMEROUN – Tél: 6992 257 777 /Fax.: (237) 222 22 64 96

E-mail : enquetepublique@anor.cm – www.anor.cm/enquetes-publiques

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Sorghum grains — Specification



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Foreword

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ARSO Central Secretariat
International House 3rd Floor
P. O. Box 57363 — 00200 City Square
NAIROBI, KENYA

Tel. +254-20-2224561, +254-20-3311641, +254-20-3311608

E-mail: arso@arso-oran.org

Web: www.arso-oran.org

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ARSO Central Secretariat
International House 3rd Floor
P.O. Box 57363 — 00200 City Square
NAIROBI, KENYA

Tel: +254-20-2224561, +254-20-3311641, +254-20-3311608

E-mail: arso@arso-oran.org
Web: www.arso-oran.org

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Introduction

Sorghum is the fifth most important cereal crop worldwide. It is drought and heat tolerant and thus an important crop in arid regions where major cereals do not produce sufficient yields. Consumption of sorghum, however, has decreased considerably in many African countries, especially in urban areas.

However, there is renewed interest in many African and foreign countries in the crop due to the wide range of applications and substitutions. Some types are boiled like rice, some cracked like oats for porridge, some "malted" like barley for beer, some baked like wheat into flatbreads, and some popped like popcorn for snacks. A few types have sugary grains and are boiled in the green stage like sweet corn. The whole plant is often used as forage, hay, or silage. The stems of some types are used for building, fencing, weaving, broom-making, and firewood. The stems of other types yield sugar, syrup, and even liquid fuels for powering vehicles or cooking meals. The living plants are used for windbreaks, for cover crops, and for staking yams and other heavy climbers. The seeds are fed to poultry, cattle, and swine. On top of all that, sorghum promises to be a "living factory." Industrial alcohol, vegetable oil, adhesives, waxes, dyes, sizing for paper and cloth, and starches for lubricating oil-well drills are just some of the products that could be obtained.

This African Standard is a technical revision of the earlier ARS 462:1987(E), *Standard for sorghum grains* which is hereby superseded and cancelled.

ENQUÊTE PUBLIQUE N° 19

Sorghum grains — Specification

1 Scope

This African Standard specifies requirements, methods of sampling and test for sorghum grains (whole or decorticated) of varieties (cultivars) grown from *Sorghum bicolor* (L.) Moench 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 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 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 9648, *Sorghum — Determination of tannin*

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 African Standard, the following terms and definitions apply.

3.1

sorghum grains

dry mature grains of the species *Sorghum bicolor* (L.) Moench

3.2

broken kernels

pieces of sorghum grain which pass through a screen having round holes of 1.8 mm in diameter

3.3

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.

3.4

decorticated grains

grains from which the external casings and whole or parts of the germ have been removed in an appropriate manner, using mechanical treatment

3.5

foreign matter

all organic and inorganic material other than sorghum, broken kernels, other grains and filth. Foreign matter includes loose sorghum seed coats.

3.6

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

3.7**test weight**

the density of a measured volume of grain expressed in kilograms per hectolitre

3.8**screenings**

all matter passing through a 2.0 mm slotted screen – 40 shakes in the direction of the slots using an agitator

3.9**food grade package**

package which safeguard the hygienic, nutritional, technological and organoleptic qualities of the products

4 Quality requirements**4.1 General requirements**

4.1.1 Sorghum grains shall meet the following general requirements/limits as determined using the relevant standards listed in Clause 2. Sorghum shall be:

- a) the dried mature grains of *Sorghum bicolor* (L.) Moench;
- b) hard, clean, wholesome, uniform in size, colour and shape;
- c) free from abnormal flavours, musty, sour or other undesirable odour, obnoxious smell and discolouration;
- d) safe and suitable for human consumption;
- e) free from micro-organisms and substances originating from micro-organisms, fungi or other poisonous or deleterious substances in amounts that may constitute a hazard to human health.

4.2 Specific requirements

Sorghum grains may be classified 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 sorghum grains

	Characteristic		Specification			Method of test
S/No.			Grade 1	Grade 2	Grade 3	
1	Moisture, % max, m/m		13.5	13.5	13.5	ISO 711, ISO 712
2	Test weight, Min (kg/hl)		71	62	62	ISO 605
3	Total admixture max (% by wt) (Total of foreign material, screenings and trash)		11.0	30.0	50.0	
4	Foreign material, % max (by wt)		2.0	3.0	4.0	
5	Foreign matter, decorticated seed (% by wt)		0.5	0.5	0.5	
6	Screenings, max (% by wt) (All matter passing through a 2.0 mm slotted screen – 40 shakes in the direction of the slots using an agitator)		11.0	25.0	50.0	
7	Trash, max (% by wt) (Chaff and other sorghum trash retained above a 2.0 mm slotted screen following the screening process)		5.0	15.0	15.0	ISO 20483
8	Crude protein, % by dry mass basis, <i>min</i>		7.0	7.0	7.0	
9	Ergot affected grains, %m/m, max		0.05			Annex A
10	Tannin content, % on dry mass basis, <i>max</i> .	Whole grains	0.5	0.5	0.5	ISO 9648
11		Decorticated grains	0.3	0.3	0.3	
12	Defective grains, max^a (% by count, 300 grain sample)	Weather stained	5.0	20.0	20.0	ISO 605
13		Field fungi	5.0	10.0	10.0	
14		Dry green	5.0	10.0	10.0	
15		Immature grain (fully green in colour)	5.0	10.0	10.0	
16		Split/broken	7.0	10.0	10.0	
17		Total defective	5.0	8.0	10.0	
18	Small foreign seeds (% by weight)		1.6	1.6	1.6	ISO 16050
19	Total aflatoxin (AFB ₁ +AFB ₂ +AFG ₁ +AFG ₂), ppb, max		10			
20	Aflatoxin B ₁ only, ppb, max		5			
21	Fumonisin, ppm, max		2			AOAC Official Method 2001.04

^a The parameter, total defective grains is not the sum total of the individual defects. It is limited to 70% of the sum total of individual defects.

^a The parameter, total defective grains is not the sum total of the individual defects. It is limited to 70% of the sum total of individual defects.

5 Contaminants

5.1 Metals contaminants

Sorghum 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 (mg/kg, 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

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

6 Hygiene

6.1 Sorghum grains 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, sorghum grains:

- shall be free from microorganisms in amounts which may represent 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 represent a hazard to health.

Table 3 — Microbiological limits

S/No.	Type of micro-organism	Limits	Test method
(1)	Yeasts and moulds, cfu, max. per g	10^4	ISO 21527-2
(2)	<i>Staphylococcus aureus</i> , cfu, max per 25 g	10^3	ISO 6888-1, -2, -3
(3)	<i>E. coli</i> , per g	Absent	ISO 7251
(4)	<i>Salmonella</i> , per 25 g	Absent	ISO 6579

7 Packaging

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

7.2 Each package shall contain sorghum grains of the same type and of the same grade designation.

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

8 Marking and 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 or Decorticated Sorghum 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 sorghum was genetically modified or not.

8.2 Non-retail containers

Information for non-retail containers shall either be given on the container or in accompanying documents, except that the name of the product, lot identification and the name and address of the manufacturer or packer shall appear on the container. However, lot identification and the name and address of the manufacturer or packer may be replaced by an identification mark, provided that such a mark is clearly identifiable with the accompanying documents.”

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) **diethyl 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 concentrated 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 feeding stuff 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 feedingstuff (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 feedingstuff (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 feedingstuff (A.2.6.1).

A.2.6 Calculation and report

A.2.6.1 Calculation

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

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

C = amount of component in mg/kg feedingstuff (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 feedingstuff 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 462:2016(E)

In pelleted feedingstuff only qualitative determination of ergot is possible.

A.2.8 Remarks

A.2.8.1 For the identification of ergot in pelleted feedingstuffs, 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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