FEDERATION OF COCOA COMMERCE

FCC QUALITY RULES

(Applicable to contracts concluded on or after 01 July 2019)

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RECORD OF AMENDMENTS

Rule No.	Title	Date of Amendment	Brief Description of Amendment
2.6	Contamination	01 March 2012	Deleted reference to taste from definition of contamination and clarified that off smells can be detected during the Cut Test
2.7	Cut Test	01 March 2012	Added definition of Cut Test
2.17	Mouldy Bean	01 March 2012	Added footnote reference to white spot
2.22	Violet or Purple Bean	01 March 2012	Added definition of violet or purple bean
3.1	General Specification	01 March 2012	Added reference to violet or purple bean
4	Quality Assessment	01 March 2012	Added reference to methodology in Rule 6
6	Methodology for residue, flat beans, bean clusters & foreign matter	01 March 2012	Added methodology for assessing residue, flat beans, bean clusters and foreign matter
7	Methodology for bean count	01 March 2012	Clarified procedure for preparation of test sample for bean count
8	Methodology for the cut test	01 March 2012	Deleted reference to germinated beans and added reference to contamination
11	Off flavours	01 March 2012	Amended definition of off-flavours. Added reference to CIRAD as default independent laboratory
14	Methodology for detection of specific off-flavours	01 March 2012	Adapted method for detection of specific off-flavours in cocoa beans
2.1	Adulteration	01 June 2015	Simplified definition
2.2	Bean cluster	01 June 2015	Definition revised to clarify method for separation of beans
2.4	Bean size standards	01 June 2015	Added definition to reflect proposed draft ISO standard
2.7	Cocoa related matter	01 June 2015	Added definition which replaces and redefines the notion of residue which has been deleted
2.13	Flat beans	01 June 2015	Revised to harmonise with Conseil du Café-Cacao
2.14	Foreign matter	01 June 2015	Clarified in a footnote that husk and placenta are to be considered foreign matter
2.16	Germinated beans	01 June 2015	Revised to harmonise with Conseil du Café-Cacao
2.19	Main crop	01 June 2015	Added definition to harmonise with ISO
2.23	Slaty bean	01 June 2015	Revised to harmonise with Conseil du Café-Cacao
Rule No.	Title	Date of Amendment	Brief Description of Amendment

3	**Specifications of quality requirements & standards**	**01 June 2015**	**Added specific parameters for cocoa related matter, flat beans and foreign matter**
3.1	**General**	**01 June 2015**	**Revised to reclassify between "free from" & "virtually free from"**
3.2	**Bean count allowances**	**01 June 2015**	**Revised to reflect transfer of main crop to definitions**
5.2	**Methodology for assessment of sievings**	**01 June 2015**	**Clarified that the net weight of the arbitration sample is to be recorded on the sample bag. Corrected the measurement procedure**
6	**Methodology for assessing cocoa related matter, flat beans & foreign matter**	**01 June 2015**	**Revised to reflect the new terminology: cocoa related matter and clarified the measurement procedure.**
7	**Methodology for assessing bean count**	**01 June 2015**	**Revised to reflect the new terminology: cocoa related matter and clarified the measurement procedure.**
8	**Methodology for cut test**	**01 June 2015**	**Clarified the procedure in relation to the cut beans.**
2.5	**Broken bean**	**01 July 2019**	**Revised to clarify definition of broken bean**

QUALITY RULES

APPLICABLE TO CONTRACTS CONCLUDED ON OR AFTER 01 JULY 2019

PART 1: GENERAL

1. APPLICATION OF QUALITY RULES

The following Quality Rules apply to all contracts incorporating the FCC Contract Rules for Cocoa Beans.

2. DEFINITIONS

In addition to the definitions in the FCC Contract Rules for Cocoa Beans, the following definitions are applicable to the FCC Quality Rules.

2.1 ADULTERATION

Means alteration of the composition of a parcel of cocoa beans by any means whatsoever.

2.2 BEAN CLUSTER

Means two or more beans joined together which cannot easily be separated by using the finger and thumb of both hands.

2.3 BEAN COUNT

Means the total number of whole beans per 100 g derived from a test sample prepared in accordance with these Rules.

2.4 BEAN SIZE STANDARDS

(a) standard beans – means bean count ≤ 100
(b) medium beans – means bean count 101-110
(c) small beans – means bean count 111-120
(d) very small beans - means bean count >120

2.5 BROKEN BEAN

Means a cocoa bean of which a fragment of the kernel is missing, the remaining part being more than half of a whole bean.

2.6 COCOA BEAN

Means a raw cocoa bean, which is the whole seed of the cocoa tree (Theobroma Cacao L.)

2.7 COCOA RELATED MATTER

Means bean clusters, broken beans and associated fragments and pieces of shell which do not pass through the sieve.

2.8 CONTAMINATION

Means the presence of a smoky, hammy or other smell not typical to cocoa, or a substance not natural to cocoa which is revealed during the Cut Test or physical inspection of an Arbitration Sample.

2.9 CUT TEST
Means the procedure set out in Rule 8 by which the cotyledons of cocoa beans are exposed for the purpose of determining the incidence of defective and/or slaty cocoa beans, and/or violet or purple beans and/or the presence of contamination within an Arbitration Sample.

2.10 DEFECTIVE BEAN
Means an internally mouldy or insect-damaged bean.

2.11 FAIR AVERAGE QUALITY
Means the quality specification for that season applicable to the cocoa origin referred to in the contract when the terms Good Fermented and Fair Fermented are not customarily applicable to that origin.

2.12 FAIR FERMENTED
Means cocoa beans that are not more than 10% slaty and 10% defective by count.

2.13 FLAT BEAN
Means a cocoa bean which is too thin to be cut to give a complete surface of the cotyledons.

2.14 FOREIGN MATTER
Means any substance other than Cocoa Beans, Cocoa Related Matter, Flat Beans and Sievings. [1]

2.15 FRAGMENT
Means a piece of cocoa bean equal to or less than half a bean.

2.16 GERMINATED BEAN
Means a cocoa bean, the seed germ of which has pierced the shell as evidenced either by the physical presence of the seed germ or by a hole in the shell following its detachment.

2.17 GOOD FERMENTED
Means cocoa beans that are not more than 5% slaty and 5% defective by count.

2.18 INSECT DAMAGED/INFESTED BEAN
Means a cocoa bean the internal parts of which are found to contain insects or mites at any stage of development, or to show signs of damage caused thereby, which are visible to the naked eye.

2.19 MAIN CROP
Means a cocoa parcel with a bean count consistent with that of beans normally produced during the main harvest period of that particular origin.

2.20 MOULDY BEAN
Means a cocoa bean on the internal parts of which mould [2] is visible to the naked eye.

1 *Husk and placenta are to be considered as Foreign Matter*
2 *Mould is not to be confused with **WHITE SPOT** which is a concentration of theobromine or cocoa fat.*

2.21 SIEVE
Means a screen with round holes the diameter of which shall be 5.0mm min./max.

2.22 SIEVINGS
Means the matter which passes through the Sieve.

2.23 SLATY BEAN
Means a cocoa bean which shows a slaty colour on at least half of the surface of the cotyledons exposed by the Cut Test irrespective of texture.

2.24 VIOLET OR PURPLE BEAN
Means a cocoa bean which shows a violet or purple colour on at least half of the surface of the cotyledons exposed by the cut test.

3. SPECIFICATION OF QUALITY REQUIREMENTS AND STANDARDS

3.1 GENERAL

Parties shall specify their quality requirements e.g. Main Crop, Good Fermented, Fair Fermented, the Bean Size Standard, the Bean Count, in the FCC Short Form Contract. Parties may also agree to incorporate the Optional Quality Clauses set out in Part 3.

In addition to any specified quality terms, the parcel shall consist of beans which shall be reasonably;

- uniform in size,
- uniform in fermentation,
- dry,
- homogeneous in all other respects

and the parcel shall be:

- fit for the production of a foodstuff,
- free from adulteration, contamination and rodents,
- virtually free from live insects (including mites) or other type of infestation,
- virtually free from germinated beans
- within the customary range for violet or purple beans of the specified grade/origin.

3.2 BEAN COUNT ALLOWANCES

For Main Crop, the following shall apply:

(a) if the bean count is 100 or less, then the parcel shall not be subject to an allowance;
(b) if the bean count is between 101 and 120 inclusive, the parcel shall be subject to an allowance;
(c) if the bean count exceeds 120, then the parcel shall be replaceable or subject to an allowance.

3.3 COCOA RELATED MATTER

If the combined weight of the Cocoa Related Matter exceeds 3.5% of the weight of the whole arbitration sample the arbitrators may award an allowance.

3.4 FLAT BEANS

If the weight of the Flat Beans exceeds 1.5% of the weight of the whole arbitration sample the arbitrators may award an allowance

3.5 FOREIGN MATTER

If the weight of the Foreign Matter exceeds 0.75% of the weight of the whole arbitration sample the arbitrators may award an allowance.

3.6 SIEVINGS STANDARDS

If the weight of the Sievings exceeds 1.5% of the weight of the whole arbitration sample the arbitrators may award an allowance.

4. QUALITY ASSESSMENT

The quality of the parcel will be assessed in accordance with the following procedure:

1. A sample shall be drawn in accordance with the FCC Sampling Rules.
2. The Assessment of Sievings shall be conducted according to the methodology set out in Rule 5.
3. The Assessment of Cocoa Related Matter, Flat Beans and Foreign Matter shall be conducted according to the methodology set out in Rule 6.
4. The Assessment of Bean Count shall be conducted according to the methodology set out in Rule 7.
5. The Assessment of Defective and/or Slaty Beans and/or Violet or Purple Beans shall be conducted by a Cut Test according to the methodology set out in Rule 8.
6. The Assessment of Contamination shall be conducted during the Cut Test or physical inspection of the Arbitration Sample according to the methodology set out in Rule 8.

Quality tests for the Optional Quality Clauses must be conducted in accordance with the relevant methodology set out in Part 4 of these Quality Rules.

PART 2: STANDARD METHODOLOGIES

5. METHODOLOGY FOR ASSESSING THE SIEVINGS

5.1 PREPARATION OF THE SAMPLE

The Arbitration Sample shall be prepared in accordance with the method described in the FCC Sampling Rules.

5.2 DETERMINATION

The entire Arbitration Sample shall be weighed and the net weight recorded on the sample bag. The entire Arbitration Sample shall then be well mixed and sieved through a screen with round holes the diameter of which shall be 5.0mm min./max.

The quantity passing through the sieve, which is known as the Sievings, shall be collected and weighed.

The percentage of the Sievings is obtained by comparing the weight of the Sievings against the total net weight of the Arbitration Sample.

Once the measurement has been effected, the matter which has been extracted for testing shall be re-integrated into the Arbitration Sample once the steps under Rules 6.2 and 7.4 are completed.

5.3 EXPRESSION OF RESULT

$$\text{Sievings (\%)} = \frac{\text{Weight of the sievings}}{\text{Total net weight of sample}} \times 100$$

6. METHODOLOGY FOR ASSESSING COCOA RELATED MATTER, FLAT BEANS & FOREIGN MATTER

6.1 PREPARATION OF THE SAMPLE

The Arbitration Sample shall be prepared in accordance with the method described in the FCC Sampling Rules.

6.2 DETERMINATION

After sieving in accordance with Rule 5, the arbitration sample shall be emptied into a tray of sufficient size to facilitate the measurement of cocoa related matter, flat beans and foreign matter.

Each category of flat beans and foreign matter and each sub category of cocoa related matter i.e. bean clusters, broken beans and associated fragments and pieces of shell shall be removed, separated, aggregated and weighed and the weight shall be expressed in relation to the weight of the Arbitration Sample.

Once the measurement has been effected, the matter which has been extracted for testing shall be re-integrated into the Arbitration Sample once the steps under Rule 7.4 are completed.

6.3 EXPRESSION OF RESULT

$$\text{Quality Parameter (\%)} = \frac{\text{Weight of the quality parameter}}{\text{Total net weight of sample}} \times 100$$

7. METHODOLOGY FOR ASSESSING THE BEAN COUNT

7.1 PRINCIPLE

The Bean count is to determine the average number of whole cocoa beans that weigh 100 gr.

7.2 PREPARATION OF THE ARBITRATION SAMPLE

The Arbitration Sample shall be prepared in accordance with the FCC Sampling Rules.

7.3 PREPARATION OF THE TEST SAMPLE

After sieving in accordance with Rule 5 and having removed the cocoa related matter, flat beans and foreign matter in accordance with Rule 6, the Arbitration Sample shall be emptied onto a clean dry flat surface and thoroughly mixed.

A Test Sample of not less than 600 grammes shall be obtained by using a flat-bottomed shovel drawn across the middle of the Arbitration Sample and weighed to the nearest 1gr.

7.4 DETERMINATION

From the Test Sample any remaining cocoa related matter, flat beans and foreign matter shall be removed, then weighed and replaced by an equivalent weight of whole beans taken randomly from the remainder of the Arbitration Sample. The total number of beans in the Test Sample shall then be counted and the resulting number is the Bean Count which shall be expressed by the number of beans per 100 grammes.

Once the measurement has been effected, the matter which has been extracted for testing shall be re-integrated into the Arbitration Sample.

7.5 EXPRESSION OF RESULT

The bean count shall be expressed as number of beans per 100 gr.

$$\text{Thus, bean count} = \frac{\text{Number of whole beans}}{\text{Weight of whole beans (gr)}} \times 100$$

8. METHODOLOGY FOR THE CUT TEST

8.1 PRINCIPLE

The cut-test is to determine the incidence of defective and/or slaty beans, and/or violet or purple beans and the presence of any contamination.

8.2 PREPARATION OF THE TEST SAMPLE

The Cut Test procedure is conducted on the Test Sample of whole beans used for the Bean Count test.

8.3 DETERMINATION

Three hundred whole beans irrespective of size, shape and condition, shall be counted off from the Test Sample and the beans shall be cut lengthwise through the middle, such that the maximum cut surface of the cotyledons can be examined by the naked eye.

Both halves of each bean shall be examined visually in full daylight or equivalent artificial light.

Separate counts shall be made of the number of beans which are defective and/or slaty. Where a bean is defective in more than one respect, only one defect shall be counted.

Once the cut test has been effected, the cut beans shall NOT be re-integrated into the Arbitration Sample.

8.4 EXPRESSION OF RESULT

The results for defective and/or slaty shall be expressed as a percentage of the number of beans examined.

Any evidence of violet or purple beans and/or contamination shall be noted and described.

PART 3: OPTIONAL QUALITY CLAUSES

The methodologies of the International Confectionery Association ("the ICA methodologies") shall always be subject to the provisions of the FCC Rules as defined in Rule 1.2 of the FCC Contract Rules for Cocoa Beans. In the event of a conflict between the ICA methodologies and the FCC Rules then the FCC Rules shall take precedence unless the contrary is expressly provided for.

9. FREE FATTY ACIDS (FFA)

9.1 DEFINITION

The free fatty acid content is the percentage by mass of the free fatty acids in the cocoa fat, conventionally expressed as oleic acid (molecular weight 282).

9.2 PREPARATION AND ANALYSIS OF THE SAMPLE

At least one arbitration sample shall be prepared in accordance with the FCC Sampling Rules. The Buyer shall instruct his supervisor/agent to forward the arbitration sample to an agreed independent analyst. The arbitration sample shall be analysed in accordance with Rule 9.5. The costs of the analysis shall be paid by the Buyer.

9.3 ARBITRATION CLAIMS

Arbitration claims for FFA shall be supported by an original certificate of analysis issued by an independent analyst in accordance with Rule 9.2.

9.4 TIME LIMITS

The time limits specified in the FCC Contract Rule for Cocoa Beans 20.1.1shall apply for FFA claims.

9.5 FREE FATTY ACID ANALYSIS

The free fatty acid content shall be determined in accordance with Analytical Method 42 (1993) of the International Confectionery Association as set out in Part 4 except that Rule 7 of Analytical Method 42 shall not apply and sampling shall instead be carried out pursuant to Rule 8.2 of these FCC Quality Rules.

9.6 STANDARDS

The Buyer and Seller shall state in the contract the percentage by mass of the free fatty acids in the cocoa fat below which a claim will not be pursued ("the permitted percentage") and, where applicable, a maximum level above which the parcel shall be replaceable ("the maximum percentage"). For values between the permitted percentage and the maximum percentage or where Buyer and Seller have not agreed a maximum percentage, the parcel shall be subject to an allowance.

9.7 APPROVED WORDING FOR SPECIFIC CONTRACTS

Free Fatty Acids, Optional Quality Rule 9, shall apply to this contract.
The Buyer may not claim for excessive free fatty acid if the percentage by mass of free fatty acids in the cocoa fat shall be "xxx" or less.

The Buyer may claim an allowance if the percentage by mass of free fatty acids in the cocoa fat shall be greater than "xxx" but less than "yyy".

The Buyer may claim for replacement of the parcel if the percentage by mass of free fatty acids in the cocoa fat shall be “yyy” or greater.

The name and address of the independent analyst upon which the parties have agreed:

Name:

Address:

10. MOISTURE CONTENT OF COCOA BEANS

10.1 DEFINITION

The moisture content of cocoa beans is conventionally the loss in mass of beans, determined by the International Confectionery Association (ICA) Analytical Method 43 - 1993 and expressed in % m/m.

10.2 PREPARATION AND ANALYSIS OF THE SAMPLE

At least one arbitration sample shall be prepared in accordance with the FCC Sampling Rules. The arbitration sample shall be placed in an air-tight container which must be filled completely by the sample to ensure that the moisture level remains constant. This container shall also be sealed by the Buyer's sampler and, if appointed, the Seller's Superintendent. The Buyer's sampler shall immediately forward the arbitration sample to an independent analyst to be mutually agreed by both the Buyer and Seller at the time of the contract in respect of which neither shall unreasonably withhold its consent. The arbitration sample will be analysed in accordance with Rule 10.5. The costs of the analysis shall be paid by the Buyer.

10.3 ARBITRATION CLAIMS

Arbitration claims for excessive moisture shall be supported by an original certificate of analysis issued by an independent analyst in accordance with Rule 10.2.

10.4 TIME LIMITS

The time limits specified in the FCC Contract Rules for Cocoa Beans 20.1.1 shall apply for claims concerning moisture content.

10.5 MOISTURE CONTENT ANALYSIS

The moisture content shall be determined in accordance with Analytical Method 43 (1993) of the International Confectionery Association as set out in Part 4 except that Rule 6 of Analytical Method 43 shall not apply and sampling shall instead be carried out pursuant to Rule 10.2 of these FCC Quality Rules.

10.6 STANDARDS

The Buyer and Seller shall state in the contract the percentage by mass of moisture in the cocoa beans below which a claim for excessive moisture will not be pursued ("the permitted percentage") and, if required, a maximum level above which the parcel shall be replaceable ("the maximum percentage").

For values between the permitted percentage and the maximum percentage or where Buyer and Seller have not agreed a maximum percentage, the parcel shall be subject to an allowance.

10.7 APPROVED WORDING FOR SPECIFIC CONTRACTS

Moisture content, Optional Quality Rule 10, shall apply to this contract.

The Buyer may not claim for excessive moisture content if the percentage by mass of moisture in the cocoa beans shall be "xxx" or less.

The Buyer may claim an allowance if the percentage by mass of moisture in the cocoa beans shall be greater than "xxx" but less than "yyy".

The Buyer may claim for replacement of the parcel if the percentage by mass of moisture in the cocoa beans shall be "yyy" or greater.

The name and address of the independent analyst upon which the parties have agreed:

Name:

Address:

11. OFF-FLAVOURS IN COCOA BEANS

11.1 DEFINITION

For the purpose of this Rule off-flavour in cocoa beans shall mean the presence of a smoky, mouldy, hammy or acidic off-flavour as defined in, and determined by the analysis of a sample according to the Methodology set out in Part 4 - Optional Quality Rule 14.

11.2 PREPARATION AND ANALYSIS OF THE SAMPLE

At least one arbitration sample shall be prepared in accordance with the FCC Sampling Rules. Should the Buyer consider that an off-flavour be present, the Buyer's sampler shall forward the arbitration sample to an independent taste-panel to have been mutually agreed by both the Buyer and Seller at the time of the contract in respect of which neither shall unreasonably withhold its consent. The costs of the analysis shall be paid by the Buyer.

If the Parties have failed to agree upon the selection of an independent taste panel then CIRAD (*Centre de coopération Internationale en Recherche Agronomique pour le Développement)* will be appointed to undertake the independent assessment of the specific off flavours or, if CIRAD are unable to act, such other competent body as may be nominated by the Federation.

11.3 ARBITRATION CLAIMS

Arbitration claims for off-flavours shall be supported by an original certificate of analysis issued by an independent analyst in accordance with Rule 11.2.

11.4 TIME LIMITS

The time limits specified in the FCC Contract Rules for Cocoa Beans 20.1.1 shall apply for claims for off-flavours.

11.5 OFF-FLAVOUR ANALYSIS

Analysis for off-flavours shall be conducted according to the Methodology set out in Part 4 – Optional Quality Rule 14.

11.6 APPROVED WORDING FOR SPECIFIC CONTRACTS

Off-flavours, Optional Quality Rule 11, shall apply to this contract.

The name and address of the independent taste-panel upon which the parties have agreed:

Name:

Address:

PART 4: OPTIONAL QUALITY CLAUSES METHODOLOGIES

12. METHODOLOGY FOR DETERMINATION OF FREE FATTY ACID (FFA)

Analytical Method 42

Determination of the Free Fatty Acid (FFA) Content of Cocoa Fat as a Measure of Cocoa Nib Acidity

Introduction

This method describes the determination of the free fatty acid content in fat obtained by soxhlet extraction of cocoa nib with petroleum ether.

1. Scope and Field of Application

Applicable to cocoa nib prior to processing.

2. References

BS 684: Section 2.10: 1988, Determination of acidity.

3. Definition

The free fatty acid content (acidity) is the percentage by mass of free fatty acids in cocoa fat, conventionally expressed as oleic acid (molecular weight 282), determined according to the method described below.

4. Principle

A quantity of cocoa nib is ground after a heat pre-treatment. This is extracted in a soxhlet extraction apparatus using petroleum ether. The solvent is evaporated and the fat residue is weighed. The fat is dissolved

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in a mixture of ethanol and diethylether and the extracted free fatty acids are titrated with an ethanolic solution of potassium hydroxide.

5. Reagents

5.1 Petroleum ether, boiling range 40-60°C, dry and without evaporation residue (see note 11.1).

5.2 Mixture of ethanol and diethylether 1/1 (v/v/):

Mix 250 ml of 95% (v/v) ethanol with 250 ml diethylether. Neutralize the mixture just before use with the ethanolic potassium hydroxide solution (5.3) in the presence of 2.5 ml of indication solution (5.4).

5.3 Potassium hydroxide solution, 0.1 mole KOH (p.a.) in 1 L ethanol 95% (v/v) (Merck art. nr. 9115 or similar) and accurately standardized using potassium hydrogen phthalate (p.a.):

Weigh into a 250 ml Erlenmeyer flask approximately 400 mg of potassium hydrogen phtalate to the nearest 0.1 mg. Add a few drops of phenolphthalein and titrate with the ethanolic potassium hydroxide solution until the solution turns pink for at least 10 seconds (calculation see 9.1).

5.4 Indicator solution, dissolve 10 g of phenolphthalein in 1 L ethanol 95% (v/v) in a 1 L volumetric flask.

6a Matters: (see note 11.1)

6a.1 Defatted glass beads, diameter approximately 5 mm.
6a.2 Fat-free extraction thimbles, e.g. S&S no. 603 (33 * 94 mm).
6a.3 Fat-free round filters, diameter 15 cm, e.g. S7S no. 597.
6a.4 Defatted cotton wool.
6a.5 Pumice stones or other anti-bumping agents, fat free.

6b Apparatus: (see note 11.2)

6b.1 Soxhlet extractor, siphon capacity about 100 ml, NS 29 cone (male) at the bottom and NS 45 cone (female) at the top.
6b.2 Condensor, Dimroth or similar, with NS 45 cone and a drying tube or a small inverted beaker on top.
6b.3 Conical flask or flat bottomed flask, 250 ml with NS 29 cone.
6b.4 Heating apparatus for flasks, firesafe (sparkless).
6b.5 Vacuum drying oven set at 80°C, or a drying oven set at 103 ± 2°C.
6b.6 Dessicator, with drying agent at the bottom and with a tap in the lid.
6b.7 Analytical balance, 0.1 mg accuracy.
6b.8 Burette, 10 ml graduated in 0.02 ml.
6b.9 Suitable mill (p.e. Retsch, sieve 4 mm, level 1).
6b.10 (Prolabo) shaking machine according to the principle of Dangoumeau, with accessory 65 ml shaking containers and marbles. Every shaking container should be provided with an exactly fitting rubber ring between container and cover, to prevent leaking.

Marbles: every container contains 14 marbles: 2 marbles 15 mm diameter, 4 marbles 10 mm diameter and 8 marbles 6 mm diameter.

6b.11 Glass funnel, approx. 95 mm diameter at the top and a stem long enough to reach into the thimble. A metal gauze with openings (about 4 mm) is put in the funnel to prevent the marbles falling into the thimble.

6b.12 Microwave oven, 750 Watt, with turn-table.

7. Sampling

See International Standard: ISO/DIS 2292, "Cocoa Bean Sampling" - 1973, or similar procedure.

8. Procedure

8.1.1 Preparation of the test-sample:

Take about 250 grams of cocoa beans and remove the shells. Put the nib obtained in a 1 L beaker and place in the microwave oven. Heat for 3.5 minutes at 750 W, interrupted every 30 seconds in order to mix the nib (if the microwave oven has a lower maxium capacity, the time should be extended and multiplied by factor 750/ (maximum number of W). Cool down and grind the complete sample using a Retsch mill (sieve 4 mm), or a similar apparatus.

8.1.2 Analysis of the test Matter:

Weigh approx. 8 grams of the ground sample to the nearest 0.1 mg. Transfer the sample quantitatively to the shaking container, in which the marbles are already present. Add 30 ml petroleum ether, close the container and shake for 5 minutes in the shaking apparatus (6b.10).

Meanwhile place the soxhlet extractor on a conical flask or flat bottomed flask of 250 ml, containing some pumice stones. This flask and contents should be previously dried and weighed. (Ml [g]).
An extraction thimble in which some glass beads and a folded filter are put, is placed in the soxhlet extractor. Then the glass funnel with gauze is placed on the extractor.

After shaking the sample as above, pour the contents of the shaking container through the funnel into the thimble (marbles remain on gauze). Rinse the container and marbles with petroleum ether. Close the thimble with a wad of fatfree cotton wool. Add enough petroleum ether to the extractor to make it siphon twice. Attach the cooler to the soxhlet extractor, place the assembly on the heating apparatus and extract during four hours.

Disconnect the flask and evaporate the petroleum ether on the rotavapor. Dry the flask in the oven at 103°C in horizontal position. Then cool it down to room temperature in a dessicator for 30

minutes and weigh the conical flask and contents again (M2 [g]). Repeat the drying (for 1 hour). Weighing and cooling in the dessicator until the difference between two successive weighings does not exceed 2 mg.
Calculate the amount of fat which is obtained
(M [g] = M2 - M1).
Continue with the procedure to determine the FFA content (8.2).

8.2 FFA determination, titration

Take the flask with the fat obtained by procedure 8.1. Add 50 ml of the neutralized ethanol/diethylether mixture to the extracted fat. Titrate, while shaking, with the ethanolic solution of potassium hydroxide to the endpoint of this titration (phenolphtalein turns pink, lasting at least 10 seconds).
Note: If the quantity of 0.1 mole/1 potassium hydroxide solution required exceeds 20 ml, use 4 grams of sample instead of 8 grams.

9. Expression of results

9.1 Method of calculation and formula

F.F.A. content (acidity) is calculated by the formula:

F.F.A. = $\frac{282\ x\ V\ x\ C}{10\ x\ M}$ [% (m/m)] as oleic acid.

M = (M2 - M1)

In which:

282 = molecular mass of oleic acid
V = volume [ml] of the standardized potassium hydroxide used for the titration.
C = concentration [moles per litre] of the standardized potassium hydroxide solution.

C = $\frac{Wp}{Mp\ x\ Vp}$

Mp = molecular weight of potassium hydrogen phthalate
Vp = volume of potassium hydroxide solution
Wp = weight potassium hydrogen phthalate

M = mass [g] of the extracted fat.
M1 = mass [g] of the conical flask and pumice stones, before extraction.
M2 = mass [g] of the conical flask after extraction.

The result should be expressed with two decimals.

9.2 Repeatability

The absolute difference between two single test results obtained in repeatability conditions, shall not exceed the following values of r :

range = 0,5 - 2.0 ; r = 0.15 [% (m/m)]

9.3 Reproducibility

The absolute difference between two single test results, obtained in reproducibility conditions, shall not exceed the following value of R :

range = 0.5 - 2.0 ; R = 0.30 [% (m/m)]

10. Test report

The test report shall indicate the method used and the results obtained. It shall also mention any operating conditions not specified in the method or regarded as optional, as well as any circumstances that may have influenced the results.

The report shall include all details required for the complete identification of the sample.

11. Notes

11.1 Thimbles, filters and cotton wool must be checked for the absence of extractable matter: per analysis the total limit of the extraction-residue is 0.5 mg.
The petroleum ether must be free of evaporation residues: when the residue exceeds 1 mg per 150 ml, then the petroleum ether has to be distilled before use.

11.2 Round bottom flasks and water- or steam baths can also be used for the extraction, then however the extraction (boiling) is more difficult to control. Condensation of water in the condenser (high air humidity) should be avoided, it might wet the sample in the thimble and make the fat unextractable.

11.3 The round filter can be shaped like a bag, by folding it around a clean rod easily fitting into the thimble. This permits repeated use of the extraction thimble and also helps in preventing very fine cocoa particles being rinsed out of the thimble into the conical flask.

11.4 During extraction, the quantity of petroleum ether in the flask always has to be at least 50 ml.

12. Literature references

12.1 International Union of pure and Applied Chemistry (IUPAC). "Standard methods for analysis of oils fats and soaps", 6th Ed., section 2.201 (Butterworths, London).

12.2 International Standard ISO/DIS 729: "Oilseeds-Determination of acidity of oils" - 1988

12.3 Nederlands Normalisatie Instituut (NNI) : Ontwerp NEN 6332.

"Onderzoekingsmethoden voor plantaardige en dierlijke olien en vetten. Bepaling van het zuurgehalte (zuurgraad zuurgetal).

12.4 Nederlands Normalisatie Instituut (NNI) : NEN 3103 "Chemische analyse, richtlijnen voor het stellen van de titer van titer vloeistoffen", hydroxide 1 en 3.

13. Collaborative study

16 Laboratories 6 samples each, in 3 split levels')
(without replicate)

') average values : 0.82 , 0.93 and 1.51 [% (m/m)].

13. METHODOLOGY FOR DETERMINATION OF MOISTURE CONTENT OF COCOA BEANS

Analytical Method 43

Determination of the Moisture Content of Cocoa Nib and Cocoa Beans

Introduction

This method describes the determination of the moisture content of cocoa nib or whole beans by drying and weighing.

1. Scope and Field of Application

Applicable to cocoa beans and cocoa nib prior to processing.

2. References

ICA method n°1 (1996) : "Determination of Moisture (Oven Method)"

3. Definition

The moisture content of cocoa nibs or beans is conventionally the loss in mass, determined by this method and expressed in [% m/m].

4. Principle

After grinding the sample is dried for 16 h in an oven, controlled at 103° C.

5. Apparatus

5.1 Suitable mill (p.e. Retsch, sieve 4 mm, level 1).
5.2 Ventilated oven, preferably fitted with a fan, capable of being controlled at 103 ± 2° C.
5.3 Dish with lid, made of metal resistant to attack under the conditions of the test, or of glass, with at least 35 cm^2 of useful surface (for example diameter 70 mm) and 20 to 25 mm deep.
5.4 Desiccator, containing an efficient desiccant.

5.5 Analytical balance.

6. Sampling and samples

See International Standard ISO/DIS 2292 - 1973, "Cocoa Beans Sampling", or similar procedure.

7. Procedure

7.1 Preparation of the test sample:

From the test sample (normally 1 or 2 Kg of beans or nibs), weigh out approximately 250 g, then homogenise and grind it using a suitable mill, in order to give a coarse granulate. Make sure that the mill does not overheat, so as to prevent the moisture content from changing.

7.2 Determination:

Quickly transfer 10 g of the test sample into a previously weighed and dried empty dish (5.3) and lid. Cover the dish immediately with its lid and weigh to the nearest 0,1 mg.

Remove the lid and place the dish (5.3), containing the test portion, on its lid in the oven (4.2) controlled at 103 ± 2° C. Leave for 16 h ± 1 h, taking care not to open the oven door during this time. At the end of this period, remove the dish, cover it immediately with its lid and place it in the dessicator (4.4). Cool down to ambient temperature (approximatively 30 to 40 min) and weigh, still covered, to the nearest 0.1 mg.

Again put the sample in the oven for one hour, cool it down in the desiccator for 30 minutes and weigh. Should the difference between this weighing and the previous weighing exceed 0.1 %, this procedure should be repeated.

7.3 Number of determination:

Carry out two completely independent determinations, each on a quantity of nib or beans which has been treated individually: grinding, taking the test portion and drying.

9. Expression of results

9.1 Method of calculation and formula

The moisture content of the sample, expressed as a percentage by mass is equal to:

$$\frac{(A+B)-C}{B} \times 100 \text{ [\% (m/m)]}$$

In which: A = weight of dish + lid in g
B = weight of sample in g before drying
C = weight of dish + lid + sample in g after drying

9.2 Repeatability

The absolute difference between two single test results obtained in repeatability conditions, shall not exceed the following value of r :

r = 0.10 [% (m/m)] in the range : 3.5 - 5.0

9.3 Reproducibility

The absolute difference between two single test results obtained in reproducibility conditions, shall not exceed the following value of R :

R = 0.42 [% (m/m)] in the range : 3.5 - 5.0

10. Test report

The test report shall indicate the method used and the results obtained. It shall also mention any operating conditions not specified in the method or regarded as optional, as well as any circumstances that may have influenced the results.

The report shall include all details required for the complete identification of the sample.

11. Literature references

11.1 International Standard ISO 2291
Cocoa Beans - Determination of moisture content
second edition - 1980-12-01

12. Collaborative study

17 laboratories with 4 samples each : 2 uniform levels ')
in duplicate.
') average values : 3.82 and 4.57 [% (m/m)].

14. METHODOLOGY FOR DETECTION OF SPECIFIC OFF-FLAVOURS IN COCOA BEANS

The Detection of Specific Off-Flavours in Cocoa Beans -
an adaptation of the International Confectionery Association Analytical Method 44

Introduction

A sensory testing evaluation method to determine the presence of specific off-flavour in a sample of cocoa beans from a specific origin.

1. Scope

The method is applicable to a sample of cocoa beans from a specified origin which is suspected of having a specific off-flavour.

The recommended number of assessors is 5 (the minimum) or 10. These assessors must be experienced in liquor tasting and must be able to recognise specific off-flavours and be subject to regular ring testing in this respect.

2. Definitions

Smoke off-flavour - a flavour which is reminiscent of wood smoke, acrid smoke, burnt rubber, smoked bacon or soot.

Mould off-flavour - a flavour which is reminiscent of mouldiness, mustiness or dampness.

Hammy off-flavour - a flavour which is reminiscent of cured meats such as bacon or ham.

Acidic off-flavour - a flavour which is reminiscent of citrus fruits (lemon, lime, orange) or acetic acid (vinegar).

An Arbitration Sample – a sample of cocoa beans prepared in accordance with the FCC Sampling Rules.

3. Principle

2 separate samples of cocoa liquor are prepared from an arbitration sample of cocoa beans suspected of having a specific off-flavour. These 2 liquor samples are tasted with 2 other liquor samples prepared from two different samples of cocoa beans from the same origin and of the same type (e.g. fine or bulk) but which are known to be free of all specific off-flavours. These 4 liquor samples are assessed by a panel of 5 or 10 assessors.

Each assessor is presented with a set of the 4 liquor samples in a different and random order and is asked to indicate the two samples in the set which exhibit the strongest specified off-flavour.

4. Apparatus

4.1 Preparation of cocoa liquor

4.1.1 A fan assisted and ventilated oven capable of maintaining 130°C ± 2°C.

4.1.2 A 30cm x 40 cm roasting tray made of 0,5 cm x 0,5 cm wire mesh or other similar perforated metal tray capable of holding 500 g of cocoa beans in a single layer.

4.1.3 A motorised mortar and pestle mill with a porcelain set capable of grinding 500g of cocoa nibs while maintaining a temperature of 50°C ± 2°C.

4.1.4 A bean breaker and winnower or scalpel and tweezers if bean shells are to be removed manually.

4.1.5 A pair of heat resistant gloves.

4.2 Sensory testing

4.2.1 A taste panel room which is quiet and odour free be maintained at a temperature close to 20° C to 22°C. The room is to be equipped with 10 cubicles each with red or white lighting, and controlled and monitored by software or other procedures which are fit for purpose in meeting the requirements of the sensory testing process and objectives set out herein.

4.2.2 Bottled mineral water.

4.2.3 Disposable plastic spoons.

4.2.4 Spit cups.

4.2.5 15ml (or larger depending upon 4.2.6) opaque sample presentation vials with lids.

4.2.6 An aluminium heating block capable of holding 4 sample presentation vials at 48°C ± 2°C.

4.2.8 Sensory evaluation forms.

5. Procedure

5.1 Preparation of cocoa liquor

Roasting the Beans

5.1.1 By a standard coning and quartering operation, a sub-sample of 500g cocoa beans is taken from the Arbitration Sample of cocoa beans.

5.1.2 Spread the 500g of beans onto the roasting tray to form a layer one

bean thick.

5.1.3 The roasting oven (4.1.1) is set at 130°C and held at this temperature with the vent fully open for at least 25 minutes before the beans are roasted.

5.1.4 As quickly as possible to avoid excessive cooling of the oven, open the door and place the tray of beans in the middle of the top shelf and close the door. Roast the beans for exactly 30 minutes from the moment the oven door is closed.

5.1.5 Wearing the heat resistant gloves, remove the beans from the oven immediately the 30 minutes roasting period has elapsed.

Removing shells

5.1.6 If a bean breaker & winnower is used, tip the beans into the bean breaker hopper and break them immediately after taking them out of the roasting oven.

5.1.7 Switch on the winnower and feed the broken beans slowly into the hopper. The winnower fan speed should be adjusted so that in the first pass of broken beans through the winnower, a shell free (less than 1% shell) nib fraction results.

5.1.8 Re-pass the shell fraction through the winnower a second time with the fan speed reduced so that a second shell free nib fraction is achieved. Repeat this step until no significant quantities of shell pass into the nib fraction.

5.1.9 Combine the shell free nib fractions.

5.1.10 If the shells are to be removed manually, use a scalpel to peel the shells from the beans.

Milling the Nibs to Produce a Liquor

The nibs should be milled immediately while still warm.

5.1.11 Warm the mortar bowl of the mill (4.1.3) to 50°C ± 2°C.

5.1.12 With the mill operating in the grinding mode, slowly over a period of 2 to 3 minutes add the broken nibs into the bowl. Grind the nibs for 60 minutes at 50°C ± 2°C to produce a smooth liquor refined to 21µm to avoid the influence of any heterogenic texture during tasting. During this period but particularly in the first few minutes of grinding, it will be necessary to remove Matter which builds up on the mortar scraper and add it back into the bowl. This can easily be done using a plastic spatula.

5.1.13 Remove the liquor from the bowl and from the pestle and collect it in

a new food grade plastic sample pot of 250ml capacity. Place the lid on the pot.

5.1.14 Clean the bowl and pestle of the mill thoroughly, using disposable tissues, before using it to mill another sample.

Freshly prepared liquor samples can either be forwarded for sensory testing immediately or if required, may be stored for up to 12 months in a freezer at -10°C.

5.2 Sensory Testing

The sensory test is arranged to allow each assessor of a panel of 5 or 10 assessors to taste the liquors at 48°C in sets of 4, each set containing two of the liquor samples suspected of having the specified off-flavour and 2 liquor samples which are known to be free from the specified off-flavour. Each set of 4 liquor samples to each assessor is arranged so that no two assessors receive the liquors and taste them in the same order.

Preparation of Cocoa Liquors for Sensory Testing

5.2.1 Use software or other procedures as per 4.2.1 to code each of the sample pots containing the 4 liquors to be tasted with a different random number.

5.2.2 Place the 4 liquors, in the coded sample pots, and 5 or 10 aluminium heating blocks (1 for each assessor) into an incubator set at 48°C to raise their temperature to 48°C. Liquors which have been stored in the freezer require to be incubated for 3 hours. No liquor should remain in the incubator for longer than 24 hours.

5.2.3 Code 4 opaque sample presentation vials per assessor, with the same 4 three digit numbers.

5.2.4 When all 4 coded liquors are at 48°C, thoroughly stir the liquor in each pot and fill each of the sample presentation vials with about 100ml of liquor from the sample pots coded with the same three digit random numbers. Place a lid on each vial.

5.2.5 Place the sample presentation vials into the aluminium heating blocks in sets of 5, according to the balanced presentation plan shown below, as viewed from in FRONT of the block, and return the aluminium heating blocks containing the sample presentation sets to the incubator set at 65°C.

For a panel of 5 assessors, assuming the 4 random numbers are A, B, C and D, the sample presentation sets should be arranged as follows:

C,A,D,B C,B,A,D B,D,C,A A,D,C,B D,B,A,C

If 10 assessors are used, a further 5 presentation sets should be prepared as

follows:

B,D,A,C D,A,B,C A,C,D,B B,C,D,A C,A,B,D

The liquors are now ready for presentation to the panel of assessors. They may be held in the incubators at 48°C for up to 4 hours during which time the sensory testing should be completed.

Conducting the Sensory Testing

5.2.6 Each assessor is be seated in a sensory testing cubicle equipped with 4 disposable plastic spatulas, a bottle of mineral water, a Cocoa Liquor Tasting Form, a pen and a spit spot.

5.2.7 Each assessor is presented with one aluminium heating block taken directly from the incubator set at 48°C and containing 4 liquors arranged in one of the sample presentation sets. The block is placed in front of the assessor so that the FRONT label on the block faces the assessor.

5.2.8 The assessor is asked to read and then carry out the instructions given on the Cocoa Liquor Tasting Form. An example of the Cocoa Liquor Tasting Form is shown below in section 5.2.9. The assessor is instructed that the samples must first be tasted in the order presented but may then be re-tasted in any order. Assessors must also be instructed not to communicate with each other during the test.

5.2.9 Cocoa Liquor Sensory Tasting Form

Taste the 4 coded cocoa liquor samples in the order presented from left to right and identify the two samples which exhibit the strongest off-flavour: (*specify the suspected off-flavour*)

The two samples are ------- and ------- (*Enter the appropriate 3 digit codes)*.

6. Expression of Results

Count the number of concurring responses. If the 2 samples of liquor prepared from the cocoa beans suspected of having the specific off-flavour are identified by 3 or more assessors of a panel of 5 assessors or by 4 or more assessors in a panel of 10 assessors, the off-flavour has been positively identified with greater than 95% confidence.

There is a small but finite probability that by chance the panel of assessors results will return a significant selection of a different pair of samples. In this event the quality of the two standard liquors should be questioned.

7. Test reports

In a two from four test the probability of a single assessor selecting the two correct samples by chance is 0.1667 = p (see[3])
and the probability of an incorrect selection is 0.8333 = q (see [4]).

- If two assessors carry out the test, the probabilities of all possible responses are calculated from the binomial expansion of $(p+q)^2=p^2+2pq+q^2$

thus the probability of 2 correct responses is p^2	=	0.027788
the probability of 2 incorrect responses is q^2	=	0.694388
the probability of 1 correct and 1 incorrect response is 2pq=		0.278222
the probability of all possible responses is then $p^2+2pq+q^2$ =		1.00

And so for 5 assessors the probability of all possible responses is $(p+q)^5=p^5+5p^4q+10p^3q^2+10p^2q^3+5pq^4+q^5$

The probabilities are then :

all 5 correct responses	p^5	=	0.00128729
4 correct and 1 incorrect responses	$5p^4q$	=	0.003217465
3 correct and 2 incorrect responses	$10p^3q^2$	=	0.032166926
2 correct and 3 incorrect responses	$10p^2q^3$	=	0.160796039
1 correct and 4 incorrect responses	$5pq^4$	=	0.401893638
all 5 incorrect responses	q5	=	0.401797203

In a similar way it may be calculated that the probability of 4 correct responses from 10 assessors is = **0.054** and the probability of 5 correct responses from 10 assessors is **0.0013.**

[2] p= (2!*2!)/4 ! =1/6
[3] q= 1- p