Elements of harmonized international standards for cocoa quality and flavour assessment

A proposal for further consultation

Version - 11 September 2017

DISCLAIMER: Please note that this document is a draft to serve as a basis for further consultation under the guidance of the Working Group on the Development of International Standards for the Assessment of Cocoa Quality and Flavours, established in Sept 2015 and coordinated by the Cocoa of Excellence (CoEx) Programme. For more information on the Working Group please consult the following webpage:

http://www.cocoaofexcellence.org/contacts/quality-and-flavour-working-group/

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Acknowledgements

A **Working Group on the Development of International Standards for the Assessment of Cocoa Quality and Flavours**, coordinated by the Cocoa of Excellence (CoEx) Programme was set up in September 2015 during the World Cocoa Foundation (WCF) Annual Seminar on Cocoa in the Americas, to explore the development of international standards for assessing cocoa quality. The vision of the standards is to enhance transparency and market access for smallholding cocoa farmers through improved quality assessment. The goal is to communicate and develop awareness of buyers, sellers and consumers of cocoa and chocolate about quality, flavour profiles and celebrate excellence of high quality cocoa and chocolate related to best agricultural and manufacturing practices. The main purpose is to standardize how actors along the cocoa value chain assess and communicate cocoa quality attributes, in an effort to improve transparency and help cocoa farmers better understand and meet quality standards demanded by buyers. To achieve this, the standards are intended to be a documented protocol for evaluating cocoa quality and flavours for use by farmer cooperatives and broad use within the sector that aligns with existing standards and needs of private sector actors while also simple enough to be used by cocoa producers and chocolate makers.

This work builds on the 2015 publication by CAOBISCO, ECA and FCC 'Cocoa Beans: Chocolate & Cocoa Industry Quality Requirements' to help improve cocoa quality, including food safety aspects. The 2015 guide is based on the BCCCA publication "Cocoa Beans: Chocolate Manufacturers’ Quality Requirements" 4th Ed (1996), revised and updated by Michelle End and Robin Dand, with a contribution from Darin Sukha and Ed Seguine, under the guidance of experts from the CAOBISCO/ECA/FCC Joint Cocoa Quality & Productivity Working Group.

The members of the Working Group represent the range of stakeholders from cocoa producers’ associations, to traders, to chocolate manufacturers and to research organizations and include the following organisations: Amacacao/KUNAKakaw, Bioversity International, Catholic Relief Services (CRS), ECOM, Cocoa Research Centre (CRC), Fine Chocolate Industry Association (FCIA), Guittard Chocolate, International Cocoa Organization (ICCO), Lutheran World Relief (LWR), Puratos, Seguine Cacao and Chocolate and World Cocoa Foundation (WCF). We are particularly grateful for the hard work and leadership of Dr Darin Sukha, CRC and for the contribution and guidance from the individuals in the Working Group, namely: Brad Kintzer (FCIA), Brigitte Laliberté (Bioversity), Daniel Domingo (ECOM), Darin Sukha (CRC), Ed Seguine (Seguine Cacao and Chocolate/Guittard Chocolate), Gilberto Amaya (CRS), Jenny Wiegel and Rick Peyser (LWR), John Kehoe (Guittard Chocolate), Juan Francisco Mollinedo (Amacacao/KUNAKakaw), Marie-Amelie Ormieres (Puratos), Moises Gomez (ICCO) and Virgininia Sopyla (WCF).

The development of standards will ensure close links with existing related initiatives such as the Fine Chocolate Industry Association (FCIA), the Heirloom Cacao Preservation Initiative (HCP), the European Cocoa Association (ECA), the Association of the Chocolate, Biscuits and Confectionery Industries of Europe (CAOBISCO), the Federation of Cocoa Commerce (FCC), the International Cocoa Organization (ICCO) and
its Expert Panel on Fine or Flavour cocoa, Regional partnerships and others. The Working Group will continue to liaise with similar initiatives in coffee (Q-grader), wine, and olive oil. Work will be carried out in consultation with private sector and relevant bodies, as well as with those working on the ground with cocoa farmers in cocoa fermentation and quality.

**Proposed Next Steps:**

1. Revise the proposal for wider consultation - including a broader participation from the industry, exporters, and producers from all regions of the world.
2. Propose a draft training course (can be several modules) for training farmer cooperatives on the proposed protocols.
3. Finalise the standards and protocols based on feedback received.
4. Publish and disseminate the international standards and protocols.
5. Develop physical reference sets for training on the international standards and protocols.
6. Propose professional training and accreditation scheme based on the agreed protocols and standards for all the supply chain actors.

The initial work carried out was an inventory of all the standards and protocols that exists to see who is doing what, what needs to be aligned and who could contribute. This included looking at what is done in coffee, wine and olive oil (and others) to apply suitable approaches to cocoa. Based on this analysis, a first proposal was developed for international standards and protocols. The next step was to propose standards for broader consultation.

The status report and proposed standards were led by Dr Darin Sukha, Cocoa Research Centre (CRC) and supported by the Lutheran World Relief (LWR), under Cacao Movil, funded by the US Department of State and Swiss Development Cooperation, and in partnership with the Cocoa of Excellence Programme.

The content of this document was produced with financial and in kind support from the Lutheran World Relief, under Cacao Movil, funded by the US Department of State and Swiss Development Cooperation, the Cocoa of Excellence Programme and the Cocoa Research Centre of the University of the West Indies, St Augustine Campus.

More information at:

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Summary

There is an urgent need to develop standardized procedures and language around assessing cocoa bean quality and its direct relation to high quality chocolate for buyers and for consumers to understand. While buyers seek different quality and flavour profiles in the cocoa they buy, establishing accepted, credible and verifiable protocols for assessing and communicating about cocoa quality attributes is urgently needed to facilitate comparison among samples with feedback to improve fermentation and drying processes for different cocoa genetics. The aim is to un-tap the value and flavour potential of these cocoas from different regions first and foremost for farmers and farmer organization to enable them to present the value proposition to potential buyers and to facilitate communication among sellers, buyers and consumers of cocoa and chocolate. The international standard will help farmers and farmers cooperatives improve their market access by increasing their capacity to improve quality and having a clear understanding of the unique characteristics and qualities of their cacao.

The vision of the standards is to enhance transparency and market access for smallholding cocoa farmers through improved quality assessment. The goal is to communicate and develop awareness of buyers, sellers and consumers of cocoa and chocolate about quality, flavour profiles and celebrate excellence of high quality cocoa and chocolate related to best agricultural and manufacturing practices. The purpose is to standardize how actors along the cocoa value chain assess and communicate cocoa quality attributes, in an effort to improve transparency and help cocoa farmers better understand and meet quality standards demanded by buyers. An essential element is therefore the documented protocol for evaluating cocoa quality and flavours for use by farmer cooperatives and broad use within the sector that aligns with existing standards and needs of private sector actors while also simple enough to be used by cocoa producers and chocolate makers.

The protocol proposed in this document contains some of the critical elements for an international standard for cocoa flavour assessment drawing from the review of current initiatives and what has happened for coffee, olive oil and wine. There are obviously various ways to carry out flavour assessments but certain fundamental considerations will be common to any approach. This is perhaps best illustrated in the concept of Six Sigma\(^1\) which was referred to and defined in the “Steps towards a harmonized international standard for cocoa flavour assessment - a review of current protocols and practices”. If one were to delve deeper into the methodologies behind this concept, a logical approach for formulating standardized methodologies to address

\(^1\) https://en.wikipedia.org/wiki/Six_Sigma
problems is presented in the RDMAIC methodology. The essential elements of the RDMAIC approach applicable to the development of a harmonized international standard for cocoa flavour assessment are:

- Recognizing the right problem to work on.
- Defining the system and their requirements.
- Measuring key aspects of the current process and collect relevant data.
- Analysing the data to investigate and verify cause-and-effect relationships. Determine what the relationships are, and attempt to ensure that all factors have been considered. Seek out the root cause of the problem under investigation.
- Improving or optimize the current process based upon data analysis and standard work to create a new process.
- Controlling the process to ensure that any deviations from the target are corrected before they result in defects. Implement appropriate control systems for the process.

This philosophy although not explicitly stated as RDMAIC, is considered logically in the elements of the proposed methodology.

Towards this end, protocols for carrying out physical bean quality assessments, preparing samples (powder, liquor and chocolate) for flavour evaluations and principal considerations for panel training, executing tasting sessions and handling data to improve and optimise current processes and achieve product and process control are presented in this document for further consideration by the larger working group.
Chapter 1 - Sampling

According to the ISO Standard 2292:1973\(^2\), correct sampling is a difficult operation which requires most careful attention and the importance of obtaining a properly representative sample\(^3\) of the lot of cocoa beans for examination cannot be over emphasised. Also, sampling during fermentation must not only consider the top 30 cm of a fermentation mass but also the middle and bottom. Samples from a cocoa drying floor must be drawn from various locations for the same batch of beans. Similarly, beans selected for processing in a flavour lab, whether at origin or in an industry quality control lab should be representative of the lot.

\(^2\) ISO 2292:1973(en) Cocoa beans - Sampling

\(^3\) A representative sample is a subset of a statistical population that accurately reflects the members of the entire population. A representative sample should be an unbiased indication of what the population is like.
Chapter 2 - Sampling Procedures

Suggested sampling procedures vary according to the lot sizes (number of bags). For lots of beans over 30 bags it is suggested that every other bag be sampled with individual bean samples being drawn from the top, middle and bottom of the bag using an appropriate stab sampler.

For lots of beans less than 30 bags, it is suggested that every bag be sampled, drawing beans from the top, middle and bottom of the bag.

The amount of beans drawn using these sampling frequencies might exceed the amount required for analysis. The coning and quartering process is then used to reduce this amount of sample to the desired quantity. This is achieved by forming all the bean samples drawn into a cone on a suitable food safe surface. The cone is then flattened and divided into four equal parts (in a cross) and only two opposing quarters are retained. The other half is returned to the lot that was sampled. This process is repeated until the desired quantity of beans for quality assessment is obtained.

It should be noted that enough sample should be retained to either conduct quality assessment in triplicate or at least have three samples (including one for retention in case more beans are needed).

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4 https://en.wikipedia.org/wiki/Sub-sampling_(chemistry)
Chapter 3 - Sample Passport Data

The sample should have some passport data associated with it, which could include:

1. Country
2. Farmer or Farm location
3. Processor
4. Date fermented
5. Dates of drying and method used
6. Turning regime used etc.

Some additional passport data that should also be collected from the sample and logged before it is handled further and could include:

1. Date arrived
2. Sample identity and origin
3. Bag or container the samples were received in
4. General comments about the sample condition (visual, aroma, presence of waste, insects, mould, broken beans etc.)
5. Internal assessment code (if used)
6. Total weight received
7. Sample storage conditions prior to receipt and before assessment.

These passport data can be logged in a dedicated hard cover note book or virtually on a suitable spread sheet or database software application allowing for easy reference. Each sample should also be assigned a unique identifier code in this database separate and apart from the submitted name.
Chapter 4 - Aging and Storage of Beans

Freshly fermented and dried beans usually have either very strong volatile fruit notes, lower cocoa flavour notes, acid notes (especially acetic acid), and a range of possible off notes. It is therefore recommended that bean samples are stored for a period of time to “age” before they are transformed into powder and/or liquor. Physical assessments are usually carried out during this time, which can vary between 6 - 12 weeks.

Aging improves stability, makes the samples more representative of commercial shipments and facilitates optimal expression of the true flavour potential of the beans. Samples should be placed in suitable food safe containers (plastic container, high quality snap seal plastic bags, draw string cotton jute or burlap bag or vacuum sealable bag). The latter is a specific consideration if aroma volatile chemical or other chemical assessments are planned for the sample.

Samples for assessment should be stored in an area that is clean with appropriate temperature and humidity control, free from insect and rodent pests or either at 20°C (68°F) for immediate and intermediate storage or at -20°C (-4°F) for longer term storage.
Chapter 5 - Physical Assessments

Physical bean quality has a direct impact on flavour quality and on the performance of that bean in a chocolate including aspects of food safety. Further to this, post-harvest processing activities play the greatest role in expressing genetic flavour potential which often determines end use of the beans. The contribution of post-harvest processing and physical bean assessment should form the first part of the “flavour evaluation” and initial quality screening should consider this element critically before a bean lot moves further along the value chain.

Whilst post-harvest processing is outside the scope of activities covered in this document, Annex 2 of the “Steps towards a harmonized international standard for cocoa flavour assessment - a review of current protocols and practices” provides an overview of the best practices in cocoa production as identified by the ICCO for good reference, as well as, in the CAOBISCO/ECA/FCC, (2015). “Cocoa Beans: Chocolate and Cocoa Industry Quality Requirements” (End, M.J. and Dand, R., Editors) drawing heavily from existing ISO Standards.

Physical assessments of cocoa bean quality are well documented and have been developed to ensure that commercial cocoa consignments can be assessed and classified using agreed terminology and methodology. This is the most organised/formalised, well understood and communicated aspect of cocoa quality assessment. There are existing International Organization for Standardization (ISO) standards governing activities carried out under physical assessments as well as older standards from the United States Food and Drug Administration (FDA).

Physical assessments are usually carried out during the storage period before the samples are processed into powder, liquor or chocolate. Assessments include:

1. Average Moisture Content
2. Bean Count
3. Individual Bean Weight
4. Cut Tests

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5 ISO 2451 Cocoa beans - Specification and quality requirements; ISO 1114, Cocoa beans - Cut test; ISO 2291, Cocoa beans - Determination of moisture content (Routine method) and ISO 2292, Cocoa beans - Sampling
5.1. Moisture Content

The exact range of acceptable moisture contents vary but almost all agree that the minimum value should be around 6.5% and should not exceed 8.5%. The desired range of limits is 6.5% - 7.5%. Bean breakage is high below 6% moisture content and the risk of mould growth great for moisture contents above 8%. Higher moistures can be re-dried either in the sun or in a convection oven set at 30°C (86°F) for a few hours with monitoring to avoid over drying.

There is an existing ISO standard for determination of moisture content using gravimetric methods but most people use moisture meters that are either hand held or benchtop. A protocol specific to any one brand or make of moisture meter will not be presented as there are various types available to assess moisture content. These vary from probe samplers that are inserted into the large 70 kg (Ca 150 lb) jute bags used to store cocoa to small meters that have a chamber to manually crush beans to assess moisture (Aqua Boy meters). The most commonly used meters (Dickey John and Burrows) use changes in capacitance to measure moisture. Whatever moisture meter used must be calibrated for cocoa beans in the range of moisture contents being assessed. It is important that the beans going into the moisture meter are at ambient temperature and not hot or cold. They also must be free from foreign material such as stones, leaves, sticks etc. to prevent sticking and damage.

5.2. Bean Count and Individual Bean Weight

Bean counts are simply the amount of beans required to make up 100 grams. There are recently revised ISO standards for cocoa bean specification which provides a methodology for bean counts. Individual bean weight is derived from the bean count by the simple formula: 100g/Bean Count. Usually bean counts above 1 gram is considered desirable and bean standard sizes considered important in industry are:

- Standard beans - bean count ≤ 100
- Medium beans - bean count 101-110
- Small beans - bean count 111-120
- Very small beans - bean count >120

There are various bean count allowances aligned to time in the cocoa crop year as well as allowances for cocoa related matter and foreign matter that are available from CAOBISCO/ECA/FCC, (2015).

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7 ISO 2291, Cocoa beans - Determination of moisture content (Routine method)
10 ibidem
5.3. Cut Tests

Cut tests are done on fermented and dried beans and is the most commonly used method to visually assess bean quality. There is an ISO standard for this\textsuperscript{11} but actual practices may vary from this and there is no cut test chart associated with this standard. For the cut test, a representative sub sample of beans (300 according to ISO rules or 100 according to FDA\textsuperscript{12}, sometimes less beans depending on local standards and lot size) are cut centrally along the longitudinal axis to expose two equal halves that are quickly examined in good light before surface oxidation has occurred.

Cutting is achieved in different ways starting on individual beans with a simple sharp knife whose blade could be serrated or not, to anvil pruning shares or via the Magra Bean cutter that allows one to cut 50 beans at once with a guillotine action. Hand cutting gives all the information you need for a defect count as well as colour and fissuring evaluation, it is more time consuming and the delicate aromas released from a cut bean can quickly fade. The Magra Bean Cutter has the advantage of allowing you to immediately smell the aroma from the beans by cutting 50 beans at once.

5.3.1. Cutting Individual Beans

When cutting individual beans either by a knife or anvil pruning shares, care must be taken to avoid damage to your hands and fingers. Beans selected for cutting must be reasonably well filled and a small cutting block can be used with a knife. Beans must be held steadily to be cut evenly along the central longitudinal axis when using both knives or the anvil pruning shears. The flat anvil of the anvil pruning shears is more stable for this action (Figure 1) as opposed to the scissors type pruning shares that has no flat surface to rest the beans on to cut.

\textbf{Figure 1: The Anvil type pruning shears with a cocoa bean resting on the anvil for cutting}

\textsuperscript{11} ISO 1114, Cocoa beans - Cut test
5.3.2. The Magra Bean Cutter

Beans selected for cutting with the Magra Bean Cutter must be reasonably plump to avoid slightly flat beans from being “missed” by the cutter. Beans should be carefully oriented with the longitudinal axis of the beans lined up with the longitudinal axis of the camber in the cutting bed. One bean must be placed per chamber in the cutter. After filling, the cutter is closed and latch engaged by finger tightening to just hold the cutter closed when the guillotine is used. The cutter is placed on its two feet on the floor or a low table and the guillotine blade inserted to begin cutting. There is only one way that the blade can enter the cutting chamber since one of the brass rails is larger than the other. Applying careful pressure (not in a jerking fashion) ensures that the blade goes down the rails vertically until it comes to a stop with the handle on the top of the cutting block. Applying even pressure whilst cutting allows for a smooth, even cut. Applying uneven pressure often results in bean breakage and a rough cut which makes examination less easy (See Figure 2).

![Figure 2: Loading and using the Magra Bean Cutter](image)

The guillotine is opened before the blade is removed by laying the cutter flat on a table and undoing the latch opening and the top part of the cutter and then removing the blade out\(^\text{13} \).\(^{13}\)

\(^13\) This information as well as some general standard operating procedures to inform this section was obtained from Ed Seguine of Seguine Cacao Cocoa & Chocolate Advisors, “Operating Procedures and Recommendations for Equipment Operation - Laboratory Evaluation of Cocoa Beans”, Version 1.0 November 23, 2014. Copyright by Seguine Cacao Cocoa & Chocolate Advisors, 2014.
5.3.3. Aroma
Immediately after cutting, aroma is best assessed by putting the beans about 2 cm (0.8 inches) away from your nose moving up and down the rows of cut beans on the Magra cutting bed or the individual cut beans if using a knife or anvil pruning shears. This gives a good initial indication on what dominant flavours might be present in the finished liquor or chocolate. Defects such as smoke and oily taints and even putrid or hammy notes from over fermentation can be detected at stage and it may be a good reason to reject or discontinue further evaluations after these defects are identified.

5.3.4. Cut Test Appearance and Colour
Examining the cut halves of the beans in full sunlight or equivalent light is desirable. Cut Test charts such as what is presented in Annex 13 of the “Steps towards a harmonized international standard for cocoa flavour assessment - a review of current protocols and practices” from the Cocoa Research Centre are useful in examining the cut based on the colour and appearance of the cut beans. Typical categories for the cut test include:

1. Well fermented (for light brown, brown, and dark brown bean categories)
2. Unfermented/slaty beans
3. Under fermented beans (violet to partly purple/partly brown)
4. Over fermented beans
5. Mouldy beans
6. Germinated beans
7. Flat beans
8. Insect-damaged/infested beans
9. Smokey beans are assessed by aroma

There are different grades and categories identified by ISO, CME, FCC and FDA based on the amount of defects and % fully fermented. A maximum 3% mouldy; maximum 3% infested are required by ISO\textsuperscript{14}. More details on these are presented in CAOBISCO/ECA/FCC, (2015)\textsuperscript{15}. The time window after cutting to do the colour evaluation before beans start to fade and change is about 30 minutes to an hour. If photographs are taken of the cut tests, they must be taken within this time and should include a MacBeth ColorChecker\textsuperscript{16} or equivalent to allow standardization of the colours due to lighting differences and camera exposure settings.

\textsuperscript{16} https://en.wikipedia.org/wiki/ColorChecker
5.3.5. Cut Test Fissuring

Apart from colour, the cut test also allows one to see the extent of fissuring in the beans. Fissuring is different from the colour changes that occur in fermentation. They are generally related but at the same time one number can be different from the other based on both the genetics of the beans as well as how the fermentation and drying were carried out. Fissuring occurs as a result of the fermentation process opening up the large scale structure of the beans as a function of proteolysis and is retained during drying. Beans that are heavily fissured are generally more fermented than beans that have a “cheesy” or “slaty” appearance when cut. There is a fissuring scale that has been published and is found in a patent US 6,582,747. In this patent, the fissuring is used as a measurement of the extent of fermentation. See Figure 3\textsuperscript{17,18}:

![Figure 3: Cocoa Bean Fissuring Chart as found in a Patent US 6,582,747](image)

The categories of fermentation based on fissuring are used, to calculate a fermentation index according to the following formula which assumes you have 50 cut beans:

1. Category 1a beans are counted and multiplied by 1
2. Category 1b beans are counted and multiplied by 2
3. Category 1c beans are counted and multiplied by 3
4. Category 1d beans are counted and multiplied by 4

\textsuperscript{17} This information as well as some general standard operating procedures to inform this section was obtained from Ed Seguine of Seguine Cacao Cocoa & Chocolate Advisors, “Operating Procedures and Recommendations for Equipment Operation - Laboratory Evaluation of Cocoa Beans”, Version 1.0 November 23, 2014. Copyright by Seguine Cacao Cocoa & Chocolate Advisors, 2014.

\textsuperscript{18} Dry cocoa mix containing a mixture of non-alkalized and alkalized cocoa solids US Patent 6582747 B2
The score is added up and multiplied by 2 to give a number between 100 and 400. This becomes the fissuring score. Fissuring scores which are 350 - 400 are well fermented beans and are generally similar to the colour based 85+ % fully fermented number. Fissuring scores that are in the 275 - 350 range are less fermented, and according to the patent have more cocoa flavanols.

All the data from the physical assessment and cut test is usually tabulated in various formats for sample dossiers but in general should consider the following information headings:

1. Bean passport data
2. General bean observations
3. Moisture content
4. Bean count/100 grams
5. Bean weight
6. Cut test typically containing (but not limited to) the following categories on one or two repetitions of varying representative amounts of beans up to 100 beans:
   a. Well fermented (for light brown, brown, and dark brown bean categories)
   b. Unfermented/slaty beans
   c. Under fermented beans (violet to partly purple/partly brown)
   d. Over fermented beans
   e. Mouldy beans
   f. Germinated beans
   g. Flat beans
   h. Insect-damaged/infested beans
   i. Smokey beans are assessed by aroma.
7. Fissuring category
8. Odour
9. Colour

This can be combined into a two tiered assessment form which is discussed further in Chapter 8.
Chapter 6 - Coarse Powder, Liquor and Chocolate preparation

With the visual and odour cues obtained from the cut test give some inference of flavour, for obvious microbiological and food safety concerns, cocoa beans should be roasted before tasting either coarse powder, liquor or chocolate. Appendix B\textsuperscript{19} of CAOBISCO/ECA/FCC (2015) provides protocols for the preparation and flavour of samples and small-scale fermentation techniques. The protocols presented in this proposal for further consultation draw heavily from Appendix B of this document\textsuperscript{20} as they are most relevant. They are presented in this document under a Creative Commons Attribution-Non Commercial-No Derivatives 4.0 International License\textsuperscript{21} and changes have been made where appropriate for the context of providing elements of a harmonized standard for further discussion.

6.1. Roasting

Roasting is one of the most important steps in the process of developing chocolate flavour after fermentation and drying. The techniques to roast cocoa beans are one of the ways that chocolate makers can bring their own unique artistic vision to their chocolate making to best express the genetic flavour potential of the cocoa they are working with. Variables such as temperature, the temperature curve (how long the temperature remains at a particular point), the degree of roast, the type of roaster used, and a whole host of other variables all make a significant impact on the flavour of the final chocolate. There is no single “right” way to roast cocoa beans though there are many “wrong” ways to execute this activity with a detrimental effect on genetic flavour potential expression. Appendix B of CAOBISCO/ECA/FCC, (2015)\textsuperscript{22} describes in detail the options for roasters, roasting trays and roasting conditions.

The type of roaster to use is governed firstly by the objective of the roast and secondly by location of the roast as well as budget and facilities available. These can range from rapid quality screening to detailed flavour × roast mapping. An overarching consideration is to avoid over-roasting or burning the bean samples.


\textsuperscript{20} ibidem

\textsuperscript{21} http://creativecommons.org/licenses/by-nc-nd/4.0/

6.1.1. Rapid Quality Screening
The main purpose of rapid quality screening is to identify flavour defects that were not apparent from visual and odour cues in the bean sample. This type of roasting does not require simultaneous temperature and time control but should be light to moderate. Converted small scale rotary type coffee roasters and rotisserie ovens (such as those from CocoaTown\(^{23}\)) are relatively simple and affordable options to consider. These units typically do not have either temperature or time control so some degree of manipulation of non-fixed variable in the system is needed to arrive at a suitable protocol for this.

6.1.2. Precise Roasting Mapping
Once a sample has been successfully screened for the presence of defects and passed this rapid quality screening. Tracking flavour profile development of particular beans with different roast temperatures and times may be necessary but not feasible at origin due to limitations of facilities and budget. Precise roasting mapping most often is done at better equipped quality control labs (at origin) or at the end use facility.

6.1.2.1. Ovens
Precise roasting mapping is best carried out in mechanical convection ovens which offer the best opportunity to achieve this objective at the quality control level with a relatively small budget. These ovens should have the desired capacity, variable control capabilities, appropriate inner chamber air flow, thermal uniformity, as well as, a recovery time of less than 10 minutes from when the door was closed to 2°C (35.6°F) below the set point. Binder\(^{24}\) and ShellLab\(^{25}\) offer popular models of suitable mechanical convection ovens that meet the above criteria.

6.1.2.2. Roasting Trays
Roasting tray options are also discussed in Appendix B of CAOBISCO/ECA/FCC, (2015)\(^{26}\) and optimally should be made from a wide (0.6 cm or 0.25 inch) stainless steel mesh with enough

\(^{23}\) http://cocoatown.com/
\(^{24}\) http://www.binder-oven.us/oven/drying-ovens/fd-series-forced-air/fd53/
\(^{25}\) http://shellab.com/product/smo5-shell-lab-forced-air-oven-5-cu-ft-120v/
stiffness in the wire so that it can be formed into a tray that is mounted onto the rack to promote air flow across the beans and loaded at a fixed quantity at a single bean depth.

At the oven capacities suggested above, for specific varietal or origin investigations, typically only one tray should be roasted at a time loaded with 300 - 400 grams of sorted beans of relatively uniform size. For roasting not linked to different cocoa origins or varieties two trays could be roasted. As long as bean size is in the range of 70 - 130 beans/100 g, the roasting conditions should not need adjustment for bean size. Where there is insufficient sample to fill the tray, “filler beans” of good quality should be used so that all roasts are carried out with the same bean loading. Dividers should be mounted in the trays when filler beans are used to keep them separate from the sample of interest.

6.1.2.3. Roasting Conditions

Roasting conditions should be chosen to maximize the flavour potential for each type of cocoa bean and would need to be mapped according to temperature, time and loading capacity for each variety and for the specific type of roaster used.

Typically, the following is used and suggested as a starting guide for individual roast mapping using a convection oven with trays:

1. Trinitario Types - 120°C for 25 minutes
2. “Forastero” Types - 130°C for 25 minutes
3. Ancient Criollo Types - 112°C for 25 minutes
4. Modern Criollo Types - 120°C for 25 minutes\(^{27}\)

The temperature × time combinations above have successfully been used in a number of initiatives mentioned in “Steps towards a harmonized international standard for cocoa flavour assessment - a review of current protocols and practices”.

The roast time should be measured starting from 2°C below the set point. These times are based on an oven recovery time of 5 - 7 minutes from the time that the door is closed to 2°C below the set point.

Generally, most modern Criollo types can be roasted following the Trinitario conditions but the selection of specific roasting conditions for this type of cocoa should seek to express intrinsic fruity and floral ancillary flavours of Trinitarios whilst preserving the delicate the nutty/caramel

notes of Criollo types. The roasting conditions for “Forastero” types should seek to bring out any ancillary flavours as well as the maximum cocoa flavour inherent in these types.

Bean size and initial moisture content of the beans prior to roasting are important considerations and samples with very low moisture contents (<6.5%) or very high moisture contents (> 8.5%) may require adjustment to be made to the roasting conditions to ensure a standardised roast for flavour evaluation.

6.1.2.4. Cooling After Roasting and Food Safety Concerns
After roasting the beans need to be cooled to room temperature by placing them on an elevated rack and cooled at ambient conditions or with a small fan on them to accelerate the cooling if necessary. Care must be taken to avoid exposure to strong odours when cooling and for appropriate food safety control, from this point onward there should be no contact of this sample with unroasted beans. Unroasted beans are considered to be a raw agricultural product that may contain pathogens prior to roasting. Ideally, handling of raw beans should be in a separate room from roasted beans for sanitation purposes.

A batch system should be used when handing roasted cocoa and unroasted cocoa, if for logistical and budget constraints they must be handled in the same space. There should also be appropriate cleaning of all counter space and contact surfaces with approved cleaning agents and sanitisers between handling unroasted and roasted bean batches.

6.2. Breaking and Winnowing
Breaking and winnowing must not be conducted in close proximity to the unroasted beans and winnowing should occur immediately following cooling of the beans after roasting (ideally between 20 - 60 minutes and not more than 3 -4 hours) for efficient breaking and to ensure that no off-flavours are picked up from the environment or the beans are not too cold. Shells come off poorly when the beans are still warm and when they have been out too long.

6.2.1. Low Throughput System
Breaking and winnowing can be done most simply by placing cooled beans in a high quality snap seal plastic bag, removing as much of the air as possible and using a rolling pin to lightly break the beans. Afterwards a home use hand-held hairdryer can be used to blow off the free shell from the nibs in a flat tray in a well ventilated area. This approach is however only feasible for a few samples. Care must be taken not to make too many small pieces of nibs with shell (fines)
from too aggressive breaking. Fine nibs do not separate well from shell in most of the small scale winnowers and are lost with the shell stream. This will reduce yield from raw beans.

6.2.2. Higher Throughput System

Higher throughput sample preparation for flavour evaluation will require at least a mechanised winnowing system. There is hand crank operated\(^{28}\) and mechanised laboratory scale mechanised individual cocoa breakers\(^{29,30}\) from CocoaTown and Capco Test Equipment with matching winnowers from CocoaTown and Capco Test Equipment. Separation is less efficient with nib yields frequently as low as 62 - 78% of the starting raw beans. This is an important consideration in determining the sample size of beans needed for roasting to meet the volume needs for flavour and other evaluations.

Residual shell in the winnowed nibs (including both loose shell fragments and pieces of shell adhering to a piece of nib) can be manually removed with tweezers to take the shell content to effectively zero to increase yields from small and/or scarce samples.

6.3. Nib Storage

Nibs should be converted into either powder or liquor for evaluation within 48 hours of winnowing. Storage of winnowed nibs is important to avoid re-humidification and picking up odours and taints. Immediate storage should be done in clean food grade containers or high quality plastic snap seal bags, preferably a multi-layer, barrier film vacuum seal type to provide barrier film protection without vacuuming.

For precise flavour profiling, nibs should not be stored longer than seven (7) calendar days (even in a sealed bag) prior to liquor milling. Storage temperature should be 10-24°C (50-75°F). If nibs are stored at temperatures less than 18°C (64°F), they must be allowed to warm to room temperature prior to opening the bag.


\(^{29}\) http://cocoatown.com/product/cocoat-power-cracker/

\(^{30}\) Limprimita breaker and winnower by Capco Test Equipment, UK
6.4. Preparation of Coarse Powders

Rapid flavour screening can be carried out on coarse powders evaluated with or without the addition of sugar. Coarse powders between 500μm can be prepared by using a 100 gram (Ca 3 oz) stainless steel blade coffee grinder. About 50 grams (1.5 oz) of roasted and winnowed nibs can be added to the grinder one tea spoon at a time whilst engaging the grinder in 10 × 1 second pulses and shaking it up and down to assist in mixing. This coarse powder can then be stored in 4 oz sterile specimen containers at 20°C (68°F) for a maximum of 2 -3 hours before tasting.

6.5. Preparation of Cocoa Liquors

There are a number of options available for milling nibs into liquor and these include:

- Table top liquidizers for coarse grinding and coarse liquor milling (up to 100 g of nibs).
- Table top and free standing mortar and pestle mills of varying capacities (100 - 500 g of nibs).
- Laboratory scale melangeurs capable of handling from 200 g up to 2.5 kg of nibs.

It is important that the nibs should be gently warmed (not more than 40°C (104°F) before milling and equipment such as bowls, pestles, and the stones from melangeurs should be pre-warmed to ensure that the cocoa butter in the sample melts and facilitates liquor grinding. The temperature of the milling mass can be measured using an infrared thermometer and should remain below 55°C (130°F). Should the temperature of the mass rise above this value, the room can be ventilated (cooled) or the mill can be turned off to allow the sample to cool off.

Exact milling times cannot be specified as this is dependent on a number of factors such as fat content of the nibs, degree of fermentation of the beans, specific mill used, condition of the stones in the mill, etc. But milling should be accomplished gently without the addition of significant external mechanical pressure. The objective is to produce liquor that will have no discernible grit. Therefore, regardless of the milling equipment used, particle size, as determined by a micrometer, is a critical parameter in determining milling end point. A particle size range between 14 - 25 microns is optimal for effective flavour evaluation without sample grit distracting significantly from the evaluation.

After milling, liquors are transferred to labelled 4 oz sterile specimen containers, covered, allowed to cool to room temperature and then stored at -20°C (-4°F) if the processing stops here and only liquors are assessed.

6.6. Keeping track of weights
Keeping tracks of weights from a batch of beans from roasting through breaking and winnowing allows calculation of the bean-to-cleaned nib yield. This process can also be continued right through until the liquor and chocolate making stage to gain and estimate of machine losses from these operations. This information guides the decision on roasting quantities and batches required for optimal yield to satisfy the needs of flavour evaluation by a tasting panel.

6.7. Chocolate Making
Sometimes based on the skill set of the tasting panel it is more desirable to prepare chocolate for tasting. It is also sometimes desirable to project how liquor flavour potential translates into chocolate as sugar and other ingredients in the matrix becomes important factors affecting or influencing the expression of the genetic flavour potential of the bean sample. Cocoa liquor tasting is also more technically challenging to perform and does require some more specialised training compared to chocolate evaluation due to more dominant acidity, bitterness and astringency. Also, the liquor alone does not often display the full flavour potential that will be present in the chocolate and sometimes flavours that are present in the liquor are not present in the chocolate and vice versa.

6.7.1. Formulation/Recipe
The recipe used in chocolate making for the purpose of creating test samples for flavour evaluation of beans from different varieties or origins is very important and standard formulations range between 65 - 70% cocoa mass with 2 - 10% added deodorized cocoa butter used. Lecithin is added to give a more desirable mouthfeel when tasting.
Recipes\(^{32}\) that have been successfully used for semi-sweet chocolate evaluations internationally in both the Heirloom Cacao Preservation (Recipe 1) and Cocoa of Excellence (CoEx) (Recipe 2) initiatives as well as an average recipe from SeguineCacao (Recipe 3) are presented in Table 1 and include:

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Recipe 1 (%)</th>
<th>Recipe 2 (%)</th>
<th>Recipe 3 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chocolate Liquor</td>
<td>65.10</td>
<td>61.00</td>
<td>55.00</td>
</tr>
<tr>
<td>Deodorized cocoa butter</td>
<td>3.00</td>
<td>5.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Sugar</td>
<td>31.55</td>
<td>33.65</td>
<td>35.00</td>
</tr>
<tr>
<td>Soya lecithin (double bleached)</td>
<td>0.35</td>
<td>0.35</td>
<td>0.35</td>
</tr>
</tbody>
</table>

The cocoa butter, sugar and soya lecithin used must be neutral tasting to avoid influencing the flavour inherent in the liquor. Sugar can be evaluated by placing a 50 - 120 g sample in a jar twice that size, securely capping the jar and warming it to 50°C (122°F). It should be held for at least 1 hour at 50°C then uncapped and immediately smelled. An acceptable result is a sugar that has no inherent odour\(^{33}\).

Just like liquor preparation, an exact milling time for chocolate cannot be accurately predetermined, fineness of grind determines endpoint. The chocolate should be refined to less than 20 microns and tested using a micrometer. Understanding how to use this how to check the zero setting daily before use are critical elements for accuracy in this step\(^{34}\).

### 6.7.2. Conching

Conching should be kept at a minimum for making these semi-sweet chocolates for flavour evaluation and should also be at a low temperature (not more than 40°C (104°F)). The actual conching time should be long enough to remove “peaky” volatile acid flavours and short enough to retain the intrinsic flavour potential of the bean as much as possible to best express its flavour potential and gauge its performance as a chocolate\(^{35}\).

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\(^{34}\) ibidem

\(^{35}\) ibidem
6.7.3. Tempering

Chocolate samples for flavour evaluation can be assessed as either un-tempered or tempered pieces. There are three many ways to achieve well-tempered chocolate by careful manipulation of temperature during the cocoa butter crystallization process. These are:

1. Manually using a marble slab.
2. Using a double boiler.
3. Using a small table top tempering machine.

Regardless of the equipment or method used, the chocolate must first be heated to 45°C (113°F) to melt all six forms of crystals. Next, it should be cooled to about 27°C (80.6°F) to allow crystal types IV and V to form. At this temperature, the chocolate is agitated to create many small crystal "seeds" which will serve as nuclei to create small crystals in the chocolate. The chocolate is then heated to about 31°C (87.8°F) to eliminate any type IV crystals, leaving just type V. Any excessive heating of the chocolate after this point, will destroy the temper and this process will have to be repeated. Moulding and cooling into small bars or pieces immediately follows tempering.

Refrigerators are not ideal for cooling moulded chocolate but are often used. When they are used, their temperature setting should not be very cold but closer to 12 - 15°C (53 - 59°F), air conditioned rooms set to 19 - 21°C (66 - 69°F) or wine chillers set to 16°C (60°F) are often used to cool filled chocolate moulds but both need to be checked prior to use to ensure they are neutral smelling and do not contain any off odours.

The time frame before flavour evaluation is important to note because the flavour profile of chocolate (particularly semi-sweet chocolate) changes (becomes more mellows) for about 2 - 4 months after being made.

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36 https://www.chocovision.com/
Chapter 7 - Flavour Assessment

Flavour testing or sensory evaluation is defined by the Institute of Food Technologists (IFT) as “...a scientific method used to (1) Evoke, (2) Measure, (3) Analyse, and (4) Interpret those responses to products as perceived through the senses of sight, smell, touch, taste and hearing”\(^{39}\). From this definition one can infer that the same rigour and attention to detail placed on sample preparation must be extended to the flavour evaluation process for both liquors and chocolates.

Flavour assessment is also covered in some detail in the CAOBISCO/ECA/FCC, (2015)\(^{40}\) document and the only standard that exists for flavour assessment in cocoa liquors is the detection of specific off flavours in cocoa beans by the IOCCC (1996)\(^{41}\) however, flavour assessment of powders, liquors and chocolate can take the following formats:

- Evaluation by a panel of skilled tasters for presence or absence of defects.
- Evaluation by a panel of unskilled tasters using Hedonic preference indicators\(^{42}\).
- Evaluation by a panel of skilled tasters providing both quantitative and qualitative assessment (including presence or absence of defects), as well as an overall global quality or preference score.
- Evaluation by a single or few highly skilled tasters providing both quantitative and qualitative assessment (including presence or absence of defects), as well as an overall global quality or preference score\(^{43}\).

Each flavour assessment format identified above has a direct implication on the type of sample assessed, amount of sample needed, the size of the panel and number of repetitions of tasting required for a robust dataset based on the inherent purpose and need of the evaluation exercise. Critical elements in this process therefore include:

- Tasting area and layout
- Panellist training or experience
- Tasting design and/or sample randomization
- Sample storage and thawing

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\(^{40}\) Ibidem


\(^{42}\) http://www.sensorysociety.org/knowledge/sspwiki/Pages/The%209-point%20Hedonic%20Scale.aspx

7.1. Tasting Area and Layout

Ideally, flavour assessments should be carried out in white tasting booths with appropriate light (red light) and temperature control, warm water and a sink etc. However, this set up could be prohibitively expensive, pragmatically, a simple air-conditioned room that is clean, free from distractions (noise and visual) and strong odours with a large enough table for the panellists to sit on comfortable chairs is sufficient. There should however, be easy access to a sink. Movable partitions can also be constructed out of non-resinous wood and painted a neutral colour with low odour water based paint to separate panellists.

Panellists should not be distracted when tasting so the layout of the room (location of samples, water and expectorant cups, scoring sheets and pencils etc.) should be the same each time, see Figure 4.

Figure 4: Arrangement of items in the tasting area and movable partitions to minimise panellist distraction
Panellists should also consider the following guidelines\(^{44}\) carefully and try to put them into practice whenever they participate in a tasting session:

- Excessively strenuous exercise, smoking, drinking alcohol or coffee or eating food (spicy or too hot) that would alter a panellists’ sense of taste or burn their tongue should be avoided at least 1 hour or preferable longer before a tasting session.
- The use of strong scents, perfumes and aftershaves should be avoided by panellists and anyone else involved in the setup of the tasting area or sample handling. Hands should be washed prior to tasting using perfume-free soap.
- Any persons suffering from colds should not attend or participate in tasting sessions or set up.
- Any instructions handed out at tasting sessions should be read carefully and understood before commencing. Panellists should feel free to ask any questions if they are unsure about the instructions.
- Panellists should avoid talking until everyone has finished tasting.
- Panellists should strive to be independent tasters by following their first instinct about a particular flavour attribute and trust in their ability.

### 7.2. Panellist Training

Some level of intensive training is required for cocoa liquor assessments whilst training for chocolate assessment is very desirable. From the flavour assessment formats presented in Chapter 7, only Hedonic (preference tasting) can be done with an untrained panel.

An intensive two-week panellist training programme is proposed in the harmonized international standard for cocoa flavour assessment to start the ongoing process towards gaining expertise on cocoa flavour evaluation of liquors. Ideally between eight - ten persons should be selected for training to make up a core of six panellists.

Levels of expertise can be defined into categories based on the level of training or taste experience such as: Beginner, Intermediate, Advanced and Master with only Advanced and Master levels being allowed to train other panellists. This notion will evolve naturally as the assessment protocol is finalised and assessment programmes are developed to certify the different levels similar to the Coffee Q Grading system discussed in Section 3.2.1.1 - The Q Grading Course of “Steps towards a harmonized international standard for cocoa flavour assessment - a review of current protocols and practices”.

A published protocol that has been used and validated in scientific research at the Cocoa Research Centre (CRC, UWI), The University of the West Indies for the last 13 years for panellist training and selection for flavour testing is given in Annex 10 of “Steps towards a harmonized international standard for cocoa flavour assessment - a review of current protocols and practices” and serves as a good reference document for this process and should form the start of the training process\textsuperscript{45}.

The first part of the process, ideally before sensory panellists are selected for further training, involves an assessment of potential panellists’ attitude towards tasting, their time and availability, health and allergies, smoking and tobacco usage as assessed via a questionnaire. See Annex 1 for a sample questionnaire used at the CRC, UWI.

### 7.2.1. Basic Tastes Identification and Threshold

Only persons selected after this screening process should start training with basic tastes identification and threshold level sensitivity identification using the following aqueous solutions (Table 2)\textsuperscript{46}.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Solution</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic Taste Identification</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweet</td>
<td>Sucrose</td>
<td>5.000g/500mL.</td>
</tr>
<tr>
<td>Bitter</td>
<td>Quinine Chloride</td>
<td>0.072g/500mL.</td>
</tr>
<tr>
<td>Salt</td>
<td>Sodium Chloride</td>
<td>0.800g/500mL.</td>
</tr>
<tr>
<td>Acid</td>
<td>Citric Acid</td>
<td>0.250g/500mL.</td>
</tr>
<tr>
<td>Astringent</td>
<td>Maleic Acid</td>
<td>0.250g/500mL.</td>
</tr>
<tr>
<td>Fruity</td>
<td>Kola Flavour</td>
<td>2mL/500mL.</td>
</tr>
<tr>
<td>Floral</td>
<td>Orange Blossom Water</td>
<td>2mL/500mL.</td>
</tr>
<tr>
<td><strong>Identification at Threshold Concentration</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acid</td>
<td>Citric Acid</td>
<td>0.100g/500mL.</td>
</tr>
<tr>
<td>Bitter</td>
<td>Quinine Chloride</td>
<td>0.009g/500mL.</td>
</tr>
<tr>
<td>Astringent</td>
<td>Maleic Acid</td>
<td>0.150g/500mL.</td>
</tr>
</tbody>
</table>

This process involves making solutions up to the concentrations as listed in Table 2 and having trainee panellists taste and identify these at normal and threshold levels of concentration. The tasting forms for this used at the CRC, UWI are presented in Annex 2.


\textsuperscript{46} ibidem.
7.2.2. Odour Recognition with Vocabulary Generation
Odour recognition with vocabulary generation follows next and is an integral part of panel training and both positive and negative odour references applicable to cocoa liquor assessment can be found in commercially available odour kits such as Le Nez du Vin.

Vocabulary generation is a relatively simple process where trainee panellists smell or taste coded samples and write down a few words on a blank sheet of paper to describe what they smelled or tasted. The panel trainer then asks each person to state what they have written and this is either written on a white board or projected onto a screen. Whilst there is usually a consensus about the attribute in question, if there are differences in descriptors, the panel trainer should facilitate the associations of differing terms into the common vocabulary or glossary of terms used by the panel.

7.2.3. Taste Training with Vocabulary Generation
The next step in the panel training process is vocabulary generation and mental association to flavour descriptors. After the initial taste identification part of training and odour recognition, panellists can now progress to associate specific flavour descriptions for cocoa liquors on suitably prepared reference samples and mixtures of reference liquors with either previous taste experiences to gain agreement on the same sensory language. This can be achieved firstly as a vocabulary generation exercises and then ranking and scoring exercises over ten (10) general flavour attributes viz. Cocoa, Acidity, Bitterness, Astringency, Fruity / Fresh Fruit, Fruity / Browned Fruit, Floral, Woody, Spicy, Nutty, Sweet, Roasted flavours. In addition, identifiable off-flavours such as Dirty/Dusty, Meaty/Animal/Leather, Over-fermented/Rotten fruit, Putrid/Manure, Smoky and Mouldy can be included. Panellists should also be encouraged to identify any other ancillary flavours or defects that are apparent in the cocoa liquors, (recorded under ‘other’ flavours).

7.2.4. Cocoa Liquor Assessment
Taste training follows next with flavour profiling with scaling and intensity training based on liquors coded with three-digit numbers and presented to trainee panellists in order of increasing intensity (least intense first). Prior to panelling, the cocoa liquor samples should be removed from storage in the sterile specimen containers, brought to room temperature and about 1.5 - 2.0 grams of liquor sample placed into small labelled plastic soufflé cups with random 3-4 digit numbers to ensure that all flavour evaluations are blind. Random numbers should avoid codes

47 http://www.lenez.com/en/home
starting with double digit zeroes (like 001 - 009). Labelling can be achieved directly on the cups with no odour, thin point permanent markers (like Sharpie brand) or by writing the codes on small paper labels that are stuck onto the cups. The plastic soufflé cups should be covered with matching tight fitting lids. The samples should be melted at no more than 50°C (122°F) for 15 - 20 minutes prior to flavour evaluation a maximum of six liquors should be tasted in any one session to prevent panellist fatigue.

After stirring and smelling, place about 1 gram of melted cocoa liquor on a small spatula and place directly on the tongue and keep it there for 20 seconds. During this time the different attributes making up the flavour profile become apparent at three contiguous time intervals viz. initial front flavour notes, middle flavour notes and residual end flavour notes. Panellists should note that some flavours either appear or disappear very quickly or are easily masked whilst other flavours could linger for a longer time with distinct after tastes.

The 10 attribute cocoa flavour profiling form used at CRC, UWI (presented in Annex 3) uses open ended 10 cm line scale that scores intensity from 0 - 10 (0 - absent and 10 - extreme) with the middle point (coinciding to a score of 5) identified by a faint line. The form considers 10 flavour attributes viz. cocoa, acid, astringent, bitter, fruity, floral, nutty, raw/beany/green, sweet/malt/caramel flavours and global quality. Panellists identify and score any “other” ancillary flavours (positive notes) or defects (such as smoky, hammy, mouldy, over ripe, dirty and unfermented) that are apparent in the cocoa liquors in a section for ‘other’ flavour. There is a space below to also record written general comments about the smell and taste of the sample.

After liquor evaluation, the following clearing procedure is used:

- Expectorate the sample
- Rinse with warm water, expectorate rinse water
- Chew 1/8 - 1/6th of a Table Water Cracker/Wafer (non-yeast based) with the front incisors and not the molars and swallow
- Rinse with warm water, expectorate rinse water
- Rinse again with warm water this time swallowing the rinse water.

The performance of the sensory panel can be optimized during evaluations by including a hidden reference samples to check panellist consistency between repetitions during training and evaluation sessions.

7.2.5. Coarse Powder Assessment

Instead of flavour assessment of cocoa liquors, training could also continue if desired, with coarse powder produced from roasted bean samples prior to conversion into milled cocoa liquors.
Following the FCCI sampling protocol presented in Annex 6 of “Steps towards a harmonized international standard for cocoa flavour assessment - a review of current protocols and practices”, this begins firstly by removing the coarse powders from storage in the sterile specimen containers and place the ground material in a stemless wine glass, and label the sample with a random three-digit identifier, avoiding codes starting with double digit zeroes (like 001 - 009).

Evaluate each sample without sugar first by agitating the material while holding your nose over the cup via tumbling or gentle stirring with a flavour and odour neutral implement. Place 1 teaspoon of material into your mouth and chew. Move it around your mouth, periodically opening your mouth while chewing, and detect aromas for 30 seconds. Expectorate and record impressions on taste and aroma. Rinse your mouth thoroughly with warm water, and expectorate the rinse water. If you experience palate overload or a sample’s astringency carries over too much, take a break.

Evaluate each sample with sugar (after evaluating all samples without sugar) by repeating the procedure with the addition of 1/8 tsp of sugar or xylitol and note any differences in aroma detection results.

7.2.6. Chocolate Assessment

Chocolates can be evaluated as either solid blocks or pieces melted at 45°C (113°F). Evaluation using solid blocks is recommended unless an assessment of the melting performance on the palate is not important. Training for chocolate tasting should include an exposure to a wide variety of different origin chocolates to build a mental library of associations linked to key chocolate flavour descriptors. Degree and quality of tempering in chocolate is assessed from its sheen and snap. There should be a nice sheen on the surface of the with not white spots or swirl marks. Assessment of physical attributes such as snap and texture can be perceived by breaking and holding a piece of chocolate between your thumb and index finger, gently rubbing it to feel the texture once it begins to melt. The texture should be smooth and you should not be able to feel the particles with your fingers.

Assess the aroma by bringing the chocolate close to your nose to inhale determining if there is a distinct or subtle smell. Determine if there are any other scents - such as vanilla, any spices, or fruit flavours

Finally, put a small piece of chocolate in your mouth, let the chocolate sit on your tongue and begin to melt. Make sure you inhale through your mouth and out through your nose - this allows for the flavours and aromas to become fully apparent. Now chew the piece three to five times and concentrate on the taste and texture whilst paying attention to the Front, Middle, End and
After taste/Finish of the chocolate whilst it is in your mouth. The chocolate assessment form used at the CRC, UWI is presented in Annex 4.

7.2.7. Intensity Scales
There are many scaling systems used in flavour descriptor assessment, 0 to 5, 0 to 10 and 0 to 15. The most commonly used are 0 to 10 and 0 to 5. For many, scoring on a 0 to 10-point scale is easier because we often think in base 10 or in a denary fashion. In such a system, the attribute intensity scores will have the following meanings where the higher numbers denote stronger flavour intensities:

<table>
<thead>
<tr>
<th>Attribute Intensity</th>
<th>Meaning</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None present</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Just a trace and may not be found if tasted again</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Present in the sample</td>
<td></td>
</tr>
<tr>
<td>3 to 5</td>
<td>Clearly characterizing the sample</td>
<td></td>
</tr>
<tr>
<td>6 to 8</td>
<td>Dominant characterization of the sample</td>
<td></td>
</tr>
<tr>
<td>9 to 10</td>
<td>Maximum. Over powers some other flavour notes in the sample</td>
<td></td>
</tr>
</tbody>
</table>

The main issue with using a 0 to 10-point scale is that for some flavour attributes (especially the ancillary flavours), the upper range of the scale is not used. Whilst the full range of the 0 to 5-point scale might get used, some panellists have difficulty getting accustomed to the narrow range as they perceive thinking and scoring in 0 to 5 as being unnatural. In the 0 to 5-point scale, the attribute intensity scores will have the following meanings:

<table>
<thead>
<tr>
<th>Attribute Intensity</th>
<th>Meaning</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None present</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Just a trace and may not be found if tasted again</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Present in the sample</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Clearly characterizing the sample</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Dominant</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Extremely dominant</td>
<td></td>
</tr>
</tbody>
</table>

The intensity scale used eventually is a matter of preference, training and experience.
7.2.8. Flavour Descriptors

One of the most difficult parts of flavour testing of both liquors and chocolates is finding the right words to describe the perceived flavours, especially since this relies heavily on a mental association to the flavour descriptors. Glossaries of flavour descriptors with comments and flavour wheels have been developed to group terms used to describe the flavours and can be used by panellists to ensure they use a common language when describing their perceptions and to aid in the interpretation of results.

The glossary of flavour descriptors used for the Cocoa of Excellence Programme was presented in Annex 5 of “Steps towards a harmonized international standard for cocoa flavour assessment - a review of current protocols and practices” as well as the Technical Guidelines for the Participation in the Cocoa of Excellence Programme and the International Cocoa Awards Celebrations 2017. The Glossary of terms for flavour evaluations with matching descriptors and examples of some origins/reference notes for calibration alone is presented in Annex 5 of this document and followed by the Flavour Wheel according to Seguine and Sukha (2015).48

Having a Global Quality indicator in the flavour testing for both liquor and chocolate is very useful as it goes beyond simple attributes of the sample but is intended to reflect an overall attribute standing. It should not be a score derived using a formula or calculation from the attributes but stands on its own for each evaluator to indicate their impression of overall quality. Many approaches to scoring Global Quality can be considered, including a 0 (worst) to 10 (best) rating which is easiest or a composite calculated score derived from physical to flavour assessment. Adequate panellist experience and exposure to a wide range of samples are critical considerations before having persons assign Global Quality scores.

7.2.9. Calibration of Persons

Calibration of persons as part of initial and then ongoing flavour evaluation training is a continuous process that is best achieved only through experience. Panellist drift is not uncommon and having factorial statistical sensory design that incorporates hidden reference liquors is a critical element to check for and manage this process. Tasting sighted calibration control samples to taste at the start of each flavour profiling session (such as a Ghana or Madagascar reference) is also very important.

Additionally, tasting at least three replications of tasting of the same samples helps in dealing with Positional Bias of sample ordering and managing carry over effects after tasting samples.

The need for appropriate reference liquor and chocolate samples and following a rigorous palate cleaning protocol, cannot be over emphasised in both panel training and maintaining panellist calibration. Group tasting of blinded reference samples followed by a discussion session is also important in achieving and maintaining panellist calibration.

7.3. Sensory Statistics

The data generated from sensory evaluations can either be captured directly in some version of a spreadsheet software programme or on paper based forms where the data will have to be transcribed into a spreadsheet for statistical treatment. Sensory statistics in panel training either test panellist consistency or identify inconsistent data but they can also show how panellists group together based on the samples assessed.

There are a wide variety of general purpose statistical software available to choose from and some come with extra capability to handle sensory data. Some relatively simple and effective statistical analyses that effectively treat sensory panel training and evaluation data include:

- Calculating means for individual panellists
- Calculating Standard Error of the Mean (SEM)
- Calculating Standard Deviation (SD)
- Analysis of Variance (ANOVA) looking at interactions between factors and panellists
- Correlation and Regression Analysis of individual panellists against the panel mean or against each other to pinpoint problem panellists
- Principal Component Analysis or Linear Discriminant Analysis on larger panellist datasets to examine groupings or clustering of panellists and/or samples

Inconsistencies can be corrected by weighting the score of the panellist in question so that it is closer to the mode of the panel. Weighting is only possible however if the panellist has a ‘consistent’ inconsistency.
7.4. Visualization of Results

Visualization of results from sensory training or sample assessment must be fit for purpose and can take the following forms:

- Simple tables of mean data from individual panellists or the entire panel for samples with:
  - SEM, SD or ANOVA significance interactions
- Simple graphs such as:
  - Line graphs
  - X-Y Scatter plots with best fit lines and R values
  - Bar graphs with SEM or ANOVA significance interactions represented
  - Radar plots or Spider Graphs

Filled “Pie Slice” Plots

Each of visualizations mentioned above have particular advantages, they may be static and stable, that make them fit for purpose and for print and online use. They however all lack the ability to be dynamic or be animated to see very quickly how trends change over time.

Recently Clay Gordon\(^{49}\) has been working with the Cocoa of Excellence Programme on a visualization approach that is dynamic and has the option to be animated to look at changes and trends over time. The graphs resemble a pie chart but the pie slices do not get wider or smaller to show changes in value. Instead, this new representation technique fills the individual pie slices to show increase in intensity. The width does not change. The pie is divided into 11 slices covering 11 flavour attributes that are grouped intuitively with groups separated by a heavier shaded line. The name and numerical value of the attribute intensity is presented on the outer rim of the slice for easy reference. This novel approach will allow one to animate how the slices are filled and one can use this to track the change of flavour from powder, to liquor to chocolate. Additionally, one can focus on a particular flavour attribute to see how this changes with time as a sub chart or use it for panellist calibration to show how taste scores change or align with experience or drift with time. Examples of these Filled “Pie Slice” Plots are shown in Figures 5 as used in the CoEx 2015 Feedback Reports.

\(^{49}\) http://www.thechocolatechronicles.com and http://www.thechocolatelifecom
Black and white vs colour versions are shown in Figure 6 to show that even with grayscale printing the graphs are still effective at showing differences between attributes.

The intention is to have the option to create these graphs as part of an online service with a database that can also be used to share sensory descriptors and compare an expert panel opinion with that of others.

Also this visualization can be used to identify people who, though not formally trained, know what they are tasting and compare their scores to a trained panel.
Chapter 8 - All-in-One Quality Assessment Forms

During the review process, quality assessments were achieved in many instances via a two-tiered approach starting first with physical bean quality assessment followed by flavour evaluation that could either be screening for the presence of defects or engaging in more detailed flavour profiling.

The need for an All-in-One quality assessment form to facilitate this process was expressed during the review process and the Fine Cacao and Chocolate Institute (FCCI) has produced the “Cacao Grader Evaluation Form” in an attempt to address this. However, the following versions have been created for this study capturing physical bean data linked to cocoa cut test and bean fissuring charts to gauge bean quality and then specific flavour attributes that could be quickly represented as radar plots. Two versions of these All-in-one rapid assessment forms (with and without the radar plot option) are presented in Annex 6.
Chapter 9 - A Document for Further Discussion

As a document for further discussion, the approach towards cocoa quality assessment started with collecting samples that are representative of the lot and then examining physical bean quality according to set criteria with limits clearly defined and suitable guides (such as cut test, colour and fissuring charts) used to assist in qualitative aspects of physical quality assessment. Pragmatically, sight, smell and touch are used in the field to get a good initial impression of bean quality. These observation skills are easy to learn, once what to look for is clearly defined. Mitigating and eliminating quality defects at this stage comes with experience and relatively small changes in post-harvest processing practices can have immense positive (or negative) impact on bean quality and the expression of genetic flavour potential.

Flavour assessment can appear to be less straightforward but this impression depends on the perspective taken. Taste impression is achieved by association to the best and worst examples of the product in question. In most (if not all) instances, identifying defects in cocoa such as mould, smoke, excessive over fermentation and under/non fermentation can be easily identified and training using suitable reference samples easily achieved. Assessment for identifying ancillary flavour can be best achieved by firstly clearly identifying the glossary of terms to be used for describing the ancillary attributes. This should be followed by facilitating clear associations to these descriptors under logical headings using references. Scaling of flavour intensity can be achieved through the use of specific standardised sensory tests. The importance of selecting suitable persons, using a suitable sensory design with sufficient replicates and hidden controls with good reference samples should not be underestimated as we move forward towards discussing elements of a harmonized international standard for cocoa flavour assessment.
Annex 1 - Sensory evaluation initial screening questionnaire used at the Cocoa Research Centre, The University of the West Indies

**Sensory Evaluation Candidate Questionnaire**

Name: ___________________________  Date: ___________________________

Please underline or fill in the spaces provided with your most appropriate response to the questions:

1. Are you "blind" to any tastes or smells?  Yes/No  
   If so please give details:______________________________________________

2. Do you suffer from (underline where appropriate) head colds, nasal congestion, hay fever?
   Less than twice a year  2-3 times a year  More than 3 times a year

3. Do you suffer from allergies that have been attributed to food?  Yes/No

4. Have you ever taken part in sensory (taste) testing before?  Yes/No

5. Do you feel that sensory (taste) testing is:
   (a) A useful analytical tool in its own right?  Yes/No
   (b) A useful analytical tool when used in conjunction with other testing methods e.g. chemical or physical?  Yes/No
   (c) Useful to allow simple differences between samples but not much else?  Yes/No
   (d) Not much use to an analytical scientist?  Yes/No

OR

(e) Do you feel that you know too little about it to offer a balanced opinion?  Yes/No

(f) Do you feel that your opinion is different from all of the above?  Yes/No

If so, please briefly outline your views:________________________________________
Sensory training and assessment sessions should last only 20-30 minutes.

6. If you are selected as an assessor, would you accept? Yes/No

7. If you accept, would you find the activity:
   (a) Interesting? Yes/No
   (b) Enjoyable? Yes/No
   (c) Challenging? Yes/No
   (d) A bit of a chore? Yes/No
   (e) All right as long as it did not interfere with other work? Yes/No

8. Are there any times when you would be regularly unavailable for training/panel sessions? Yes/No

If so please give details:

9. What times are most convenient for you to participate in sensory evaluation sessions?

10. Are you willing to be part of a sensory assessment panel on a long term basis? Yes/No

11. Any comments on being included on a panel to evaluate cocoa liquor (the base for chocolate)?

Thank you for your time! 😊
Annex 2 - Basic Tastes Identification and Threshold Level Tasting Forms used at the Cocoa Research Centre, The University of the West Indies

<table>
<thead>
<tr>
<th>Basic Taste</th>
<th>Sample Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet</td>
<td></td>
</tr>
<tr>
<td>Salty</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
</tr>
<tr>
<td>Acid</td>
<td></td>
</tr>
<tr>
<td>Bitter</td>
<td></td>
</tr>
<tr>
<td>Astringent</td>
<td></td>
</tr>
<tr>
<td>Floral</td>
<td></td>
</tr>
<tr>
<td>Fruity</td>
<td></td>
</tr>
</tbody>
</table>

**Sensory Evaluation Screening**

*Screening Test I*

Name: ........................................................................................................

Date: ........................................................................................................

**Identification of Basic Tastes**

**Instructions**

You are given eight (8) solutions, each containing one of the tastes listed in the table below. Please taste each one in turn and indicate below (Tick Box ☑) which taste is present in each solution.

Since sensitivity to the different tastes varies across the tongue, please make sure that the whole tongue is covered by the solution.

Please rinse your mouth with water between each solution.
Sensory Evaluation Screening

Screening Test II

Name:........................................................................

Date:........................................................................

Recognition of Taste Thresholds

Instructions

You are given three (3) solutions, each containing one of the tastes listed in the table below. Please taste each one in turn and indicate below (Tick Box ☑) which taste is present in each solution.

Since sensitivity to the different tastes varies across the tongue, please make sure that the whole tongue is covered by the solution.

Please rinse your mouth with water between each solution.

<table>
<thead>
<tr>
<th>Basic Taste</th>
<th>Sample Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid</td>
<td></td>
</tr>
<tr>
<td>Bitter</td>
<td></td>
</tr>
<tr>
<td>Astringent</td>
<td></td>
</tr>
</tbody>
</table>
Annex 3 - Cocoa Liquor Flavour Profiling Form used at the Cocoa Research Centre, The University of the West Indies

<table>
<thead>
<tr>
<th></th>
<th>Absent</th>
<th></th>
<th>Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocoa flavour</td>
<td>0</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Acidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Astringency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bitterness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruity flavour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floral flavour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutty flavour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw/beany/green</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweet/Caramel/Malt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other flavours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global Quality</td>
<td>0</td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

Comments:...........................................................................................................
..............................................................................................................
..............................................................................................................
..............................................................................................................
..............................................................................................................
Annex 4 - Chocolate Assessment Form used at the Cocoa Research Centre, The University of the West Indies

Chocolate Assessment Form

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Appearance</td>
<td></td>
</tr>
<tr>
<td>Aroma/Smell</td>
<td></td>
</tr>
<tr>
<td>Taste</td>
<td></td>
</tr>
<tr>
<td>(i) Front</td>
<td></td>
</tr>
<tr>
<td>(ii) Middle</td>
<td></td>
</tr>
<tr>
<td>(iii) End/Aftertaste</td>
<td></td>
</tr>
<tr>
<td>Mouth feel</td>
<td></td>
</tr>
</tbody>
</table>

Suggestions/Comments:
Annex 5 - Flavour glossary

Cocoa of Excellence (CoEx) Programme: Glossary of terms for flavour evaluation
with matching descriptors and examples of some origins/reference notes for calibration.
Reference: Cocoa of Excellence Technical Committee, June 2017

<table>
<thead>
<tr>
<th>Attribute Intensity</th>
<th>Meaning</th>
<th>Common intensity usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None present</td>
<td>Absent - Low intensity</td>
</tr>
<tr>
<td>1</td>
<td>Just a trace and may not be found if tasted again</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Present in the sample</td>
<td>Medium intensity</td>
</tr>
<tr>
<td>3 to 5</td>
<td>Clearly characterizing the sample</td>
<td></td>
</tr>
<tr>
<td>6 to 8</td>
<td>Dominant characterization of the sample</td>
<td>Strong intensity</td>
</tr>
<tr>
<td>9 to 10</td>
<td>Maximum. Over powers some other flavour notes in the sample</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Description</th>
<th>Examples of Origins/References (for calibration)</th>
</tr>
</thead>
</table>
| Cocoa      | Typical flavour of cocoa beans that are well fermented, roasted and free of defects. Cocoa flavour of chocolate bars. | • Absent - low intensity = 0 - 2 (unfermented cocoa, some Criollos)  
• Medium intensity = 4 - 6 (fully fermented, Indonesia, PNG and Arriba)  
• Strong intensity = 8 - 9 (West Africa) |
| Acidity    | Perceived at the front of the tongue. Total acidity is the sum of the individual acidities: Acid - Fruit: citric or other fruit acids  
Acid - Acetic: vinegar (you can smell it in the sample)  
Acid - Lactic: sour milk, yogurt, vomit like in some extreme cases  
Acid - Mineral / Butyric: metallic tasting, rancid | • Absent - low intensity = 0 - 2 (West Africa)  
• Medium intensity = 3 - 5 (Arriba, Peru)  
• Strong intensity = 6 - 8 (PNG and Malaysia) |
| Bitterness | Perceived on the rear of the tongue/ top of the throat.  
• Caffeine (coffee), some beers, grapefruit | • Low intensity = 1 - 2 (some ancient Criollo)  
• Medium (normal) intensity = 3 - 5 (West Africa)  
• Strong intensity = 6 - 8 (unfermented cocoa) |
| Astringency | The mouth drying effect that boosts the production of saliva. Perceived between tongue and palate, at the back of the front teeth and inside lips and gums or a mild velvety sensation on sides of mouth and tongue.  
• Raw nut skins, green banana skins, tannins in some wines or beers | • Low intensity = 2 - 3 (some ancient Criollos)  
• Moderate (normal) intensity = 3 - 4 (West Africa)  
• Medium intensity = 5 - 6 (Arriba)  
• Strong intensity = 7 - 10 (unfermented cocoa) |
| Fruity / Fresh Fruit |  
• Fruit - Berry: red or black currant, raspberry, blackberry  
• Fruit - Citrus: orange, lemon, lime, grapefruit, or generic sensation to be a citrus  
• Fruit - Dark: cherry, plum  
• Fruit - Yellow / Orange / White flesh: apricot, peach, pear  
• Fruit - Tropical: banana, passion fruit, pineapple, mango, soursop | • Absent - low intensity = 0 - 2 (West Africa)  
• Medium intensity = 3 - 5 (some Central America, Venezuela, fermented Asia Pacific)  
• Strong intensity = 6 - 7 (some Central America, PNG, some Trinidad (TSH)) |
| Fruity / Browoned Fruit |  
• Fruit - Dried: dried apricots, barberries, raisins, fig that has undergone the drying process  
• Fruit - Brown: dark raisin, date, prune  
• Fruit - Over ripe: over ripe fruit as a step to over-fermentation | • Absent - low intensity = 0 - 2 (West Africa)  
• Medium intensity = 3 - 5 (fully fermented Indonesia)  
• Strong intensity = 6 - 7 (PNG, some Caribbean origins, over-fermented beans) |
| Floral (1/2) |  
• Floral - Grassy / Green vegetal / Herbal:  
  - fresh cut grass, young green leaf  
  - green vegetal, mature crushed leaves, dark green note, green beans, cooked bell peppers, dark green vegetables  
  - herbal / dried green herbs like thyme, rosemary, hay, straw | • Absent - low intensity = 0 - 2 (West Africa)  
• Medium - strong intensity = 3 - 7 (Arriba, Savina, some Trinidad (TSH), Ecuador Ariba and some Peru origin beans tend to be floral, herbal, as well as floral orange blossom, earthy) |
<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Description</th>
<th>Examples of Origins/References (for calibration)</th>
</tr>
</thead>
</table>
| **Floral** (2/2) | - Floral - Earthy / Mushroom / Moss / Woody:  
  - earthy, smell of dampness coming up from the soil after the rain  
  - mushroom, damp moss, rich base note associated with earthy  
  - woody, decomposing wood  
  - Floral - Orange blossom: orange blossom flavour specifically  
  - Floral - Flowers: scent / perfume of flowers such as jasmine, honeysuckle, rose, lilac | - Absent - low intensity = 0 - 2 (West Africa)  
  - Medium - strong intensity = 3 - 7 (Arriba, Scavina, some Trinidad (TSH), Ecuador Arriba and some Peru origin beans tend to be floral, herbal, as well as floral orange blossom, earthy) |
| **Woody** | - Wood - Light wood: ash, beech, maple, white pine, cut cocoa tree  
  - Wood - Dark wood: oak, walnut, teak  
  - Wood - Resin: pine pitch, cedar, resin | - Absent - low intensity = 0 - 2 (various origins, varies by clone and fermentation)  
  - Medium intensity = 3 - 5 (West Africa, often, but not always, associated with well fermented beans) |
| **Spicy** | - Spicy - Spices: nutmeg, cinnamon, cloves, cardamom, paprika, tonka, vanilla, pepper  
  - Spicy - Tobacco: the smell of pipe tobacco or dried tobacco leave  
  - Spicy - Savory / Umami: sodium glutamate, umami effect | - Absent - low intensity = 0 - 2 (most origins, Spicy is a less common attribute)  
  - Medium intensity = 3 - 5 (some Ivorian beans, the spice tobacco is seen in West Africa, particularly Ivorian beans) |
| **Nutty** | - Nutty - Nut flesh: the edible kernel of a nut, hazelnut, macadamia nut, pecan nut, walnut, peanut, cashew  
  - Nutty - Nut skins: sharp astringent sensation like skins of hazelnuts and walnuts and other raw nuts | - Frequently just as a trace / mild note = 2 - 3  
  - Can be pronounced = 5 - 8 (some ancient Criollo) |
| **Sweet** | - Sweet / Caramel / Panela / Browed sugar / Sucrose: describes liquors with a characteristic sweet flavour from a range of white refined sugar to unrefined caramelized cane juice (panela) | - Absent - low intensity = 0 - 2 (West Africa)  
  - Medium intensity = 3 - 4 (some Venezuela)  
  - Strong intensity = 5 - 8 (some ancient Criollo) |
| **Roasted** | - A measure of the extent of roasting | - 0 = no browned notes, raw beans  
  - 5 = medium roast  
  - 10 = severely burnt |
| **Off Flavours** | - Dirty / Dusty: unpleasant character, dusty road  
  - Meaty / Animal / Leather: cured meat, ham, rendered fat, rancid animal fat, leather store, horse saddles with dirty animal notes like sweet or urine  
  - Over-fermented / Rotten fruit: decomposition of fruit, associated with over-fermentation or non-uniform fermentation  
  - Putrid / Manure: wet decomposing vegetal matter, wet center of a compost heap, farm yard animal manure  
  - Smokey: contamination from burning vegetative matter, other smokey off flavours, diesel fumes  
  - Mouldy: characteristic of mould growth, blue cheese | - More frequently found in unfermented / badly under-fermented cocoa beans  
  - Can also be associated with use of some diseased beans in fermentation or improper fermentation  
  - Associated predominantly with diseased beans and some severe over-fermentation / non-uniform fermentation  
  - Absorbed during drying or storage in a smoke-filled room  
  - Beans can show internal mould in cut test and not necessarily taste mouldy. Beans showing no internal mould in the cut test may taste mouldy either because of sampling variation or contamination with mould taint flavours |
| **Global Quality** | It reflects the overall impression of:  
  1. the expressed flavour potential  
  2. the uniqueness of the sample  
  3. the balance of flavour and cleanliness of the finish  
  It celebrates the expression of genetics and terroir diversity through the farmer’s knowhow/savoir-faire. | - No off flavour must be present and bitterness and astrignency must be in balance and in moderate/normal range in giving a high scoring (>8) for Global Quality.  
  - Zero for Global Quality means a serious and overwhelming flaw is present. This is not a “veto” but is a clear statement of the quality - or in this case lack thereof. |
Figure 7: Flavour wheel according to Sukha and Seguine (2015) with main categories and sub categories for both liquor and chocolate.
Annex 6 - Physical and Sensory Quality and Flavour Evaluation Form

Cocoa Bean Physical and Sensory Quality and Flavour Evaluation Form

Information about the evaluator

| Name of evaluator: | | |
| Date of evaluation: | | |
| Institute: | | |
| Country: | | |

Cocoa bean Sample Code

**Overall Impressions**

| Global Quality | Scale 0-10 |
| Uniqueeness | | |

**Physical Quality Assessment**

External Attributes (100 g beans)

- Bean Count
- Moisture Content %
- Bean Weight (g)
- Debris % by weight (g)

External Defects (100 beans)

- Black Beans
- Surface Mould
- Germinated Beans
- Clumped/Double Beans

Cut Test (100 beans)

- Cut/Damaged Beans

Degree of Fermentation

- Fully Brown
- Light Brown
- Part Purple/Part Brown
- Violet turning purple
- Violet unfissured

Defects

- Mouldy

Scale 0-10
Germinated  
Insect Infested  
Over fermented  
Unfermented/Slaty  

<table>
<thead>
<tr>
<th>Sensory Quality Assessment</th>
<th>Scale 0-10</th>
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<tbody>
<tr>
<td>Cocoa</td>
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</tr>
<tr>
<td>Astringency</td>
<td></td>
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<tr>
<td>Bitterness</td>
<td></td>
</tr>
<tr>
<td>Roast Degree</td>
<td></td>
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<tr>
<td>Fresh Fruit</td>
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<tr>
<td>Browned Fruit</td>
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<tr>
<td>Floral</td>
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<td>Woody</td>
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<tr>
<td>Spicy</td>
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<td>Nutty</td>
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<tr>
<td>Caramel</td>
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<tr>
<td>Other</td>
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<table>
<thead>
<tr>
<th>Defects</th>
<th>Scale 0-10</th>
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<tbody>
<tr>
<td>Dirty</td>
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<tr>
<td>Hammy/Meaty/Animal</td>
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<tr>
<td>Leather</td>
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<tr>
<td>Putrid/Overfermented</td>
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<td>Smokey</td>
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<td>Mouldy</td>
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</tbody>
</table>

Radar Plot of key flavours

Comments:

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Flouring Scale

FIG.1a

FIG.1b

FIG.1c

FIG.1d

Cut test Photos

Cocoa Cut Test Chart

Slightly Over Fermented

Well Fermented

Well Fermented (Faint)

Slightly Under Fermented

Slightly Turning Violet

Violet

Violet Turning Brown

Partly Purple and Partly Brown

Moody

Moody and Infected