Storage of wet Arabica parchment prior to wet hulling including the storage of dry green bean coffee[1]

"Origins of Mandheling Coffee Character"

Study completed under Project GCP/INT/743/CFC – CFC/ICO/06:

'Enhancement of Coffee Quality through the Prevention of Mould Formation'

Abstract: Mandheling coffee is a uniquely flavoured and high valued coffee produced in North Sumatra, Indonesia. The origins of the Mandheling character are not understood. A trial which stored wet parchment for up to 2 weeks and stored semi-dry green bean for 3 weeks (to replicate local farmer/trader conditions) found no clear evidence that this process influenced the creation of Mandheling character. The existence of an identifiable Mandheling character was verified as 3 out of 4 tasters picked a single sample from 42 blind tasted samples as having the best Mandheling character. Mandheling character was indentified by all tasters in the samples provided to them, however the character was not strong and the incidence could not be linked to the treatments. It appears that Mandheling character does exist. However, factors not considered or controlled in this trial are probably important in the development of this character.

The trial provided evidence that the best Mandheling character resulted when wet parchment was wet hulled promptly and dried directly to 12% mositure content (Process L). The trial also provided evidence that drying coffee in parchment and not wet hulling (Process M) produced a cleaner, more acidic, coffee.

The trial results support general beliefs that prolonged storage of wet parchment increases the risk of musty flavours due to mould growth, that sour flavours can result from prolonged wet storage of wet parchment and that increased cup acidity is associated with coffee that is stored as wet parchment, or dried slowly. However, in contrast to these general beliefs, cup quality was much higher than expected for many of the samples stored as wet parchment for up to two weeks.

Low levels of ochratoxin A (OTA) were detected in only 7 out of 42 samples.

The process of creating Mandheling character is still unclear and further investigation of the variables surrounding the wet hulling process is recommended.

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1. SUMMARY

Background:
Mandheling coffee is renowned in the world of speciality coffee. Mandheling is the generic name for the range of coffees from Northern Sumatra, exported out of the port of Medan, which have a spicy flavour, complex, earthy body and low acidity. There is no clear understanding how this Mandheling character is derived. The character is likely to be complex relationship between the four key factors of: a) coffee variety, b) growing environment, c) farm management, and d) processing. The relative importance of each of these factors and the interactions between them in the formation of Mandheling character is unclear.

As the signature flavour of North Sumatran coffees, coffee with good Mandheling character commands a differential premium over the New York 'C' coffee price of between US$ 1,000 to US$ 2,000 per ton (approximately a 40% to 80% price premium on a New York 'C' price of US$ 1.00/lb). Exports of this coffee have grown progressively from 12,000 tons in 1992, and the Indonesian Coffee Exporters Association (ICEA) estimates that 30,000 tons of coffee will be exported through the port of Medan during the 2004/2005 season, mostly under the banner of "Mandheling coffee". Most of this coffee derives from smallholder production, involving long processing and marketing chains stretching from the mountains of North Sumatra and Aceh to the Port of Medan. Rising demand for this internationally renowned speciality coffee has resulted in increasing quality and consistency issues.

Trial Methodology:
It likely that the long marketing and processing chains, combined with the unique wet hulling process, may be a key factor in creating the Mandheling character. The unique wet processing of Mandheling coffee also makes it susceptible to mould infection and possible ochratoxin A (OTA) contamination.

A trial was conducted during the 2004/2005 season to test the ability of various processing techniques to produce the Mandheling character, while at the same time evaluating mould infection and OTA contamination. The trial produced 42 samples from 6 sources of coffee in North Sumatra Province. Seven different processes were applied to each of the 6 coffee sources. Six of the 7 processes aimed to replicate typical occurrences in the marketing chain from farm gate to export warehouse. Fresh, clean, wet parchment gathered from farmers in the 6 source areas was wet hulled after 1 day, 1 week and 2 weeks of wet parchment storage. Coffee from each of these 3 processes was then dried to 12% moisture content (m.c.) or held at 17% m.c. as semi-dry bean for 3 weeks before final drying to 12% m.c.

The seventh process applied to each source was a 'Control Process' where parchment was dried intact, in a process normally used for high quality Arabicas, to produce clean, acidic coffee.

Mould infection evaluations were completed on each of the 6 sources of wet parchment held for 1 day, 1 week and 2 weeks and for each of the 42 dry green bean samples. OTA analysis was conducted on of each of the 42 dry green bean samples.

All coffee that was wet hulled used a standard Indonesian made Kemajuan Huller. This huller is designed to hull dry parchment of 11-14% m.c., but is modified to hull

parchment of 35-45% m.c. It is a typical 1000kg/hr 'screw' parchment huller design, which has the steel huller bar replaced with a rubber strip. It is also powered up from 15hp to 25hp, and speeded up from 600rpm to 750rpm.

The 42 numbered 300g dry green bean samples were sent for blind cup tasting and evaluation to 4 commercial coffee companies with considerable experience in North Sumatran coffees. Each company provided detailed results.

Analysis:
The trial but was unable to consistently replicate the 'Mandheling character' in any of the 7 process groups or the 6 source groups. Tasters commented that, in general, the range of coffee samples did not have normal Mandheling character or appearance, being too clean in the cup, with body not as complex and too green in colour. However, Mandheling character was identified in a number of samples. Sample No. 2 was identified by 3 out of the 4 tasters as having the best Mandheling character.

A number of the control process samples (Process M) of traditional drying of coffee in parchment (compared to the 6 other wet hulling of parchment treatments) were rated as having high acidity and cleanliness. However, once again there was inconsistency in the results as other tasters did not pick any difference in the Process M samples.

Process L, one day wet storage of parchment, fast wet hulling and fast drying of green bean, also appeared to give the highest likelihood of producing a Mandheling character. Samples in Process Group L included sample No 2, picked by 3 out of 4 tasters as the best Mandheling character, and sample No 9 selected by 2 out of 4 tasters as the second best Mandheling character

There were some wide variations between the 4 tasters' evaluations on what was considered high or low Mandheling character. Sample No 2 was identified by 3 tasters as the highest Mandheling character, but it was also identified by 1 taster as having the lowest Mandheling character. This may indicate that this flavour is unique and identifiable, but that there are different definitions for Mandheling character within the coffee industry.

A number of other samples were identified as having Mandheling character by each of the tasters but there seemed to be little correlation between Mandheling character and source, or Mandheling character and the processing techniques used. This would indicate that some other factors are involved in the process which creates the Mandheling character.

A detailed statistical analysis of all the cup taste results may show preferences or trends toward one process or one source for Mandheling character. This, however, has not been completed as none of the processes clearly gave a consistent Mandheling character.

Mould infection clearly increased with length of time of storage of wet parchment, which was to be expected. This was verified by the higher incidence of musty flavours in the final green bean of these samples. There did not appear to be any correlation between total fungal infection and specific fungal species infections and the samples which showed Mandheling character.

Infection by ochre group fungi, which include the strong OTA producer *Aspergillus ochraceus,* was found to be present in 5 out of 6 wet parchment samples stored for two weeks. For all other storage periods, ochre group aspergilli were not detected in wet parchment. In the case of the green bean, low levels of ochre group infection were detected in several of the treatments.

Low levels of OTA (ranging from 0.07 – 2.24 ppb) were detected in 7 samples. Four of these corresponded to samples that had been prepared from parchment that had been stored at high moisture for 14 days.

Conclusions:
It appeared that holding coffee as wet parchment increased the risk of producing musty coffee. While some samples held as wet parchment for 1 or 2 weeks were rated as clean, others were identified as dirty/musty, and Mandheling character was also identified by some tasters in coffees treated in this manner. The wet storage of parchment for one or two weeks in the market chain before wet hulling, or the storage of semi-dry bean before final drying by exporter appears not to be the primary factor in creating Mandheling character.

It appears that rapid wet hulling of wet parchment after fermentation and washing gives the best chance of producing Mandheling character and reduces the risk of, a) musty flavours due to mould, b) sour flavours due to prolonged wet storage of wet parchment and, c) increased acidity associate with coffee that is stored as wet parchment or dried slowly. The unique process of 'wet hulling' would appear to be an integral part in this process. What part of the mechanism it plays is not clear.

Mandheling character is a very important economic component of the US$ 70 million coffee industry of Aceh and North Sumatra. The Mandheling character may contribute up to US$ 30 million value to this industry. Maintaining this quality and consistency is important to the continued growth and value of this industry. Greater understanding of the factors that produce the Mandheling character are needed, and further study is clearly warranted.

2. BACKGROUND

History of Mandheling Coffee:
Today a range of grades of Arabica coffee are exported via the port of Medan from the Provinces of North Sumatra and Aceh. These coffees are traded under a range of names and definitions which include Mandheling Grade 1, Grade 2 and Grade 3; Gayo Mountain Grade 1; Triple Picked Mandheling; and Lintung Grade 1, Grade 2 and Grade 3. These names have evolved over more than 200 years of coffee trading since Arabica coffee was first planted in Sumatra in the 1780s.

The Mandheling description appears to have originated from a Japanese coffee buyer who returned to Medan in 1969 seeking a coffee that he had tasted during his WWII service in Sumatra. Mandheling appears to be the home of the local coffee sellers he encountered during his wartime service. The name has stuck, and Mandheling has become a generic name for the low acid, complex body coffees produced in North Sumatra and Aceh. Many names are used now as coffee growing areas have expanded in Aceh and North Sumatra, but Sumatra/Mandheling is still commonly used.

Descriptions of Mandheling Character:
To understand the unique character of the coffee from Northern Sumatra it is interesting to see a selection of the descriptions of the Sumatra/Mandheling character gleaned from the Internet and from personal communications with those involved in the industry. The following is a summary of some of the descriptions of the Sumatra/Mandheling coffees:

- "A heavy body coffee, without any acidity with full spicy flavour and a wonderful bouquet";

- "Considered one of the world's finest coffees, undoubtedly the most full-bodied coffee available. Low in acid, but rich and smooth";

- "Very full body, very concentrated flavour. Sweet, slightly earthy, herbal nuances with a gutsy richness";

- "The flavors are sweet and somewhat earthy with pronounced herbal nuances. The flavors and full body brought out by the roast make an exceptional cup. It's not the most refined or elegant coffee you can drink, but its gutsy and earthy richness is very seductive";

- "Sumatra has a full, syrupy body with virtually no acidity – so the coffee's intensity lingers in your mouth. The concentrated spicy, herbal notes and earthy aroma are the telltale signatures of this well-loved coffee";

- "Sumatran's have a deeply and opulently sweet, bracing, bitter edge of spice, herb and nostril tingling cedar, astringent saltiness, low-toned tropical fruit, bananas, grapefruit, tamarind, cherryish".

Wet Hulling Description:
While it has been suggested that the Mandheling flavour may be a result of environment, coffee variety, management of the coffee, or use of organically growing systems, it is likely that the long marketing chain and the unique wet hulling process will have some key part to play in developing this flavour. An understanding of how the wet hulling process differs from the traditional process of hulling dry (11% to 14% m.c.) process is important.

Essentially the same huller/polisher is used for dry hulling and wet hulling. It is a screw huller of Dutch colonial design now manufactured by Kemajuan Industries based in Malang, Java. The huller has a nominal one ton per hour load for dry parchment, but for wet parchment the metal hulling rib is replaced with a rubber strip, the motor power is increased from 15 to 25 hp, and the speed of the huller is increased from 600rpm to 750rpm. Throughput is around 800kg of wet green bean per hour. Wet parchment is hulled at between 35 to 45% moisture content.

3. TRIAL METHODOLOGY

A full description of the Trial Protocol is provided in Annex 1, which details procedures and data collection. A brief summary of the trial and the samples generated are provided here:

Trial Methodology:
Six lots of 600kg of wet parchment were bought directly from collectors, ensuring the coffee quality was as consistent (same day of pulping and location) as possible.

The 6 sources of coffee were:

Source	Origin
Lot I (A)	Parik Sabungan, Sub-district Siborong-borong, District North Tapanuli
Lot II (B)	Sipintu-pintu, Sub-district Siborong-borong, District North Tapanuli
Lot III (C)	Silando/Sianjur, Sub-district Siborong-borong, District North Tapanuli
Lot IV (D)	Tangga Batu, Sub-district Balige, District Toba Samosir
Lot V (E)	Silangit, Sub-district Siborong-borong, District North Tapanuli
Lot VI (F)	Parsoburan, Sub-district Parsoburan, District Toba Samosir

Chronology of Activities:
The chronology of coffee processing activities was as follows:

- Processed, by farmers, collected from farmers and prepared for drying:
  - Harvest and pulping is **Day -1**, then ferment
  - Wash and ½ day skin dry is **Day 0**
  - Collect in the afternoon of **Day 0** and deliver to warehouse
  - Blend each parchment lot (A to F) in the warehouse morning of **Day 1**

- At **Day 1**: Take initial samples from each lot for coisture content, A_w, mould and OTA contamination:
  - 40kg of each of these 6 lots will be dried as conventional parchment (**Process M**)
  - 180kg of each of these 6 lots will be hulled wet **Day 1** (Fast process)
  - Half the coffee from this batch will be dried to 17% m.c. (**Process K**)
  - Half of this batch will be dried to 12% m.c. (**Process L**)
  - The remaining 380kg will be kept in typical trader storage conditions
  - Temperature should be measured at the centre of the stored sacks each day

- At **1 week** of storage, 180kg of the 6 batches of coffee will be:
  - Sampled for m.c., A_w, mould and OTA contamination
  - Hulled wet and sun dried as green bean
  - Half the coffee from this batch will be dried to 17% m.c. (**Process I**)
  - Half of this batch will be dried to 12% m.c. (**Process J**)

- At **2 week** of storage the remaining 200kg of the 6 batches of coffee will be:
  - Sampled for m.c., A_w, mould and OTA contamination
  - Hulled wet and sun dried as green bean
  - Half the coffee from each batch will be dried to 17% m.c. (**Process G**)
  - Half of each batch will be dried to 12% m.c. (**Process H**)

- **Storage of dry coffee**: The 6 x 3 x 2 lots of green bean along with the 6 lots of previously dried parchment will be put into typical trader storage (42 samples):
  - 12% and 17% m.c. coffee will all be shipped to Jember for the storage component of the trial
  - 17% m.c. coffee will be stored for approximately 3 weeks and then dried to 12% m.c., then stored with original 12% coffee
  - These 42 lots will be sampled at 1 month, 3 months and 6 months of storage
  - The trial will be conducted at Siborong-borong in North Sumatra, and Jember in East Java

Coffee Samples Produced:
42 coffee samples of approximately 15kg of green bean each were produced from 6 coffee sources using the 7 processes described in the methodology. As an example from Coffee Source A of 600kg of parchment, the following samples were produced:

- Sample No 1 Control: dried as parchment to 12% m.c. (Process M)
- Sample No 2 Wet hulled after Day 1, dried to 12% m.c. (Process L)
- Sample No 3 Wet hulled after Day 1, dried to 17%, stored for 3 weeks, then dried to 12% m.c. (Process K)
- Sample No 4 Stored as wet parchment till Day 7, wet hulled and dried to 12% m.c. (Process J)
- Sample No 5 Stored as wet parchment till Day 7, wet hulled, stored for 3 weeks then, dried to 12% m.c. (Process I)
- Sample No 6 Stored as wet parchment till Day 14, wet hulled and dried to 12% m.c. (Process H)
- Sample No 7 Stored as wet parchment till Day 14, wet hulled, stored for 3 weeks then, dried to 12% m.c. (Process G)

Similarly, 7 samples were produced from each of the other 5 sources:

- Sample 8 to 14 from Source B
- Sample 15 to 21 from Source C
- Sample 22 to 28 from Source D
- Sample 29 to 35 for Source E
- Sample 36 to 42 from Source F

4. ANALYSIS OF TRIAL RESULTS

Data Collected:
A description of the trial protocol is contained in Annex 1. A range of data was collected during the trial. Data collected in the trial is included in a summarized form in Annex 3, Tables 1 to 8. Data included in these Tables is as follows:

Cup tests	Tables 1 to 4
Mycological analysis of green bean	Table 8
Mycological analysis of wet parchment	Table 7
General trial data temperature, A_w and moisture of parchment during storage	Table 6
Commencement of trial status, coffee sources & notes on storage of parchment	Table 5

Cup Tests - General Comments:

- Four commercial coffee companies were sent 42 numbered samples. The tasters were not informed what treatments had been used. They were not aware that some were samples were specifically prepared to produce a clean, acidic coffee normally associated with full washed dry hulled process and not the wet hulled process.
- The results of the 4 companies have been presented as Taster 1 to Taster 4 in this report.
- Tasters were asked to rate each using 4 rating systems and report their findings on the Evaluation Form provided:

  - **Mandheling character rating:** This is not a documented rating system and relied on taster's experience to rate the samples against their experience of Best to Worst (10 to 1) Mandheling Character.
  - **SCAA rating:** This is a well described rating system and relies on rating the intensity of 5 coffee components. The 5 components are scored individually from 10 to 1 (Fragrance, Acidity, Flavour, Body, Aftertaste). These scores are then totaled along with a final Cuppers Points (-5 to +5). 50 points are then added to give a score out of 100. The SCAA system used is for the general evaluation of Specialty coffee, and is not ideal for Mandheling as it is an intensity rating system. A good Mandheling should score low in acidity intensity. The most useful component of the SCAA system in this evaluation is the Cuppers Points as it is an overall evaluation of the coffee.
  - **DP/TP rating:** The DP/TP (Dry Process/Triple Pick) is not defined as a specific character and the rating relied on the taster's experience to rate the samples against their experience of Best to Worst (10 to 1). It was an attempt to rate the samples against a common coffee type sought after by buyers of Sumatran coffee. Traditional Mandehlings are typically low acid, heavy bodied, with earthy character, while the DP/TP represent a sweeter, more acid, with lower defects and clean cupping coffees.
  - **Verbal comments:** Most tasters gave verbal comments about each sample.

Cup Tasting Results (See Annex 3, Tables 1 to 4):

A. Mandheling Character Rating: Each of the 4 tasters rated the coffee from 1 to 10*. There is clear a range of coffees present. One taster's scores ranged from 1 to 10, while another other only ranged between 3 and 5. The highest and lowest ratings of each taster were compared to determine if there was any agreement between tasters.

- **Taster 1**: 4 coffees were rated 8/10 and above, with sample 2 given the highest rating of 10/10. 6 coffees were given the lowest rating of 1/10.
- **Taster 2**: 3 coffees were rated above 8/10 and above, with sample 2 given the highest rating of 7/7 (converted to 10/10). 17 coffees were given the lowest rating of 1/7 (converted to 1.4/10).
- **Taster 3**: 3 coffees were rated above 6/10, with sample 2 receiving the highest score of 6.7/10.
- **Taster 4**: 4 coffees were all rated 5/10. 10 coffees were rated the lowest of 3/10.

* Taster 2 original scores given as rating from 1 to 7 were converted to 1 to 10 for comparison.

Mandheling ratings: Highest and lowest by each taster

Taster 1		Taster 2		Taster 3		Taster 4	
Highed rated Samples	Lowest rated samples	Highest Rated Samples	Lowest Rated Samples	Highest Rated Samples	Lowest Rated Samples	Highest Rated Samples	Lowest Rated Samples
2 (A, L)	1(A, M)	2 (A, L)	1 (A, M)	2 (A, L)	4 (A, J)	21 (C, G)	1 (A, M)
9 (B, L)	4 (A, J)	4 (A, J)	5 (A, I)	22 (D, M)	11 (B, J)	25 (D, J)	2 (A, L)
10 (B, K)	6 (A, H)	9 (B, L)	7 (A, G)	27 (D, H)	25 (D, J)	32 (E, J)	3 (A, K)
21 (C, G)	8 (B, M)		12 (B, I)	34 (E, H)	29 (E, M)	42 (F, G)	5 (A, I)
	24 (D, K)		14 (B, G)		32 (E, J)		9 (B, L)
	25 (D, J)		18 (C, J)				12 (B, I)
	36 (F, M)		19 (C, I)				13 (B, H)
			20 (C, H)				14 (B, G)
			24 (D, K)				24 (D, K)
			26 (D, I)				
			28 (D, G)				
			33 (E, I)				
			34 (E, H)				
			35 (E, G)				
			39 (F, J)				
			40 (F, I)				

Notes: Brackets ( ) indicate coffee source A to F and processes M to G.

Analysis of Mandheling Ratings:

- Sample No 2 was selected by 3 of 4 tasters as the highest rate Mandheling character.
- Sample No 1 was selected by 3 of 4 tasters as the lowest rated Mandheling character.
- It does not appear that any process (M to G) or source (A to F) consistently rated as high or low Mandheling character.

B. SCAA Scores:

Three of the four tasters gave data in this section. Total score is not likely to be relevant, as Mandheling character should score very low acidity. Individual elements such as Cuppers Points rating, Acidity (low) rating and Body rating were 3 factors to consider. There does no appear to be any trends in the SCAA data toward any process group or source.

C. DP/TP scores:

Three tasters rated the coffee from 1 to 10 for DP/TP. There is no clear definition for this coffee but it is generally described as cleaner and sweeter than typical Mandheling. There is clear a range of coffees present. One taster's scores ranged from 1 to 7, while another other only ranged 3 to 5. Analysis of these rating shows no trends toward any individual sample, process group or source group.

D. Verbal Comments on cups:

Comments appear to relate to characteristics that clearly stand out in the cup. Many comments appear to be negative rather than positive. No instructions were given on how verbal comments should be made and the descriptions are those used by the tasters in their normal commercial assessments.

Common Characteristics described in the samples be each taster

Character Described	Taster 1	Taster 2	Taster 3	Taster 4
Fermented/Fruity	12(B,I) 19(C,I) 24(D,K) 33(E,I)	5(A,I) 12(B,I) 18(C,J) 19(C,I) 24(D,K) 28(D,G) 33(E,I) 35(E,G) 40(F,I)	24(D,K)	5(A,I) 14(B,G) 24(D,K) 33(E,I) 40(F,I)
Musty	2(A,L) 3(A,K) 9(B,L) 10(B,K) 23(D,L) 30(E,L) 32(E,J) 37(F,L) 41(F,J)			
Sour	19(C,I) 23(D,L) 34(E,H) 40(F,I)		4(A,J) 7(A,G) 11(B,J) 16(C,L) 25(D,J) 32(E,J)	
Sweet	20(C,H)			25(D,J)
Acid	1(A,M) 6(A,H)		4(A,J)	

Notes: Brackets ( ) indicate coffee source A to F and processes M to G.

Analysis of Verbal Comments:

- It is difficult to compare the comments, as each taster tends to have their own vocabulary and focus on specific characteristics of the coffees sample for their own commercial needs.
- Fruity/Fermented was term used by all tasters, and should be the easiest and commonest negative character to identify in the cup. All 4 tasters picked sample No 24.
- Some samples which rated highest in the Mandheling rating also had negative comments again them which demonstrated that there are issues in the processing of the coffee.

5. MOULD ANALYSIS

Table 5, 6, 7 and 8 in Annex 3 provide details of the mycological situation of the coffee samples throughout the trial process. Information includes:

- The 6 lots of wet parchment Day 1, Day 7 and Day 14 (Table 7).
- A mycological analysis of the dry green bean (Table 8).
- The A_w and temperature of 6 sources of wet parchment from Day 1 to Day 14 (Table 6).

The percentages given in the Tables for various moulds and yeast numbers are the % of beans with a particular fungus or yeast established in the tissues of the bean. The coffee samples taken for analysis are surface-sterilized, so only infections protected by the bean tissue survives. This means that the total infection, when adding up the individual species, can exceed 100%.

Analysis of Mycological Data:

Table 7 indicates that the 6 lots of parchment stored wet for 1 day, 1 week and 2 weeks show a progressive build up of fungal infection. This is similar to a general trend that the wet parchment that was stored for 1 weeks and 2 weeks were generally considered more

musty/fruity - but not critically damaged.

Table 8 shows the mycological results from the 42 green bean samples. There does not seem to be any trends between observed Mandheling character of samples and the mycological results of those same samples. The clear trend that wet parchment held for 2 weeks (Processes G & H) has vastly more infections on the than parchment held for 1 day (Processes K & L) does not appear to be the same for these same final green bean samples. While there is a range of infection rates in green bean, there does not seem to be any trend relating to type of process the coffee sample has undergone.

OTA Contamination:
Each of the 42 samples was tested for OTA. Low levels were found in 7 samples, but were within limits that might be considered tolerable for green coffee.

6. CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER WORK

Mandheling character is very important economic component to the US$ 70 million Northern Sumatran coffee industry of Aceh and North Sumatra, and may be worth up to US$ 30 million. Maintaining product quality and consistency is important to the continued growth and value of this industry, and a greater understanding of the factors that produce this Mandheling character are needed. Further work is required on aspects of food safety, as well as on coffee character, quality and consistency.

Due to practical constraints, the present work did not control for some upstream factors that could be influential in the development of the Mandheling character. Coffee samples used in the experiment were taken from small traders and represent a mixture of parchments prepared by different farmers.

A survey of farming practices in three districts of N. Sumatra has shown that there are 4 main coffee varieties used by farmers, but no work has been undertaken to investigate whether this might have an effect on cup character. Furthermore, some farmers carry out fermentation under water, while others use dry fermentation. Many farmers and traders believe this to be an important factor in the determining quality, although there have been no studies to support this belief. It is important that such factors be better taken into account in future work.

Specific areas of further study might include:

- The role of wet hulling in creating the Mandheling character;
- Food safety aspects of 'wet hulled coffee';
- Coffee varieties planted in North Sumatra and effect on cup character;
- Assessment of the existence of Mandheling character over a wide region in North Sumatra and Aceh;
- Development of standardised descriptions and definitions of the low acid/high bodied coffees of North Sumatra.

7. ACKNOWLEDGEMENTS:

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ANNEX 1

EXPERIMENTAL PROTOCOL

STORAGE OF WET ARABICA PARCHMENT PRIOR TO WET HULLING (INCLUDING STORAGE OF DRY COFFEE)

1. OBJECTIVES

The objectives of this experiment are:

- To compare the risks of OTA contamination of wet Arabica parchment which has been delayed from wet hulling (after pulping of cherry fermenting and washing) for periods from 2 days (fast), 1 week (medium) to 2 weeks (slow):
  - This will be compared to a control sample, which is dried normally as parchment to 12% moisture to produce a clean, acidic cup Arabica coffee.
- To compare the risks of OTA contamination of parchment dried Arabica (control) and 3 wet hulled Arabica treatments (fast, medium, and slow), under 2 storage treatments:
  - Hulled wet, dried to 17% m.c. and stored for 3 weeks and dried to 12% m.c.
  - Hulled wet, dried to 12% m.c. and stored.

2. RATIONALE

North Sumatra has a unique system of processing Arabica coffee. Arabica is traded wet (50% m.c.) from farmer to trader. A number of trading and storage steps can take place before the wet parchment is eventually hulled wet, at 40-50% moisture content. The hulled green bean is then sun dried.

It is known that there are commonly delays between the production of wet Arabica parchment and its hulling. This possible source of mould production and should be investigated.

Once hulled, the coffee is dried as green been. It is common that this green bean (*asalan*) is stored at 17% moisture content by traders for up to 3 weeks, and then dried to 12% m.c. by exporters. It is possible that storage at 17% m.c. is a source of mould contamination and should be investigated.

Much of the North Sumatran Arabica coffee is marketed under the name Mandheling coffee (also called Lintong and Ankola), and has a reputation for low acidity and complex body. It is thought that this flavour is a direct result of the unique wet processing and trading system used in the area. It is important to understand more clearly how this flavour process occurs so that changes to the processing system can be recommended if there is risk if OTA contamination <u>without affecting the flavour of the traditional coffee</u>.

3.

OVERVIEW OF EXPERIMENT

- 6 lots of 600kg of wet parchment will be bought directly from collectors, ensuring the coffee quality is as consistent (same day of pulping and location) as possible:
  - As much information about the source and origins of this coffee will be recorded.
  - The necessary arrangements will be made with the farmers and collectors before they harvest the cherries, to ensure that the parchment is acquired for the experiment immediately after its production.
    - Assume harvest and pulping is **Day -1** , then ferment
    - Wash and ½ day skin dry is **Day 0**
    - Collect in the afternoon of **Day 0** and deliver to warehouse
    - Blend lot in the warehouse morning of **Day 1**

- At **Day 1**: Take initial samples for moisture content, A_w, mould and OTA contamination:
  - 40kg of each of these 6 lots will be dried as conventional parchment
  - 180kg of each of these 6 lots will be hulled wet Day 1 (fast process)
  - The remaining 380kg will be kept in typical trader storage conditions
  - Temperature should be measured at the centre of the stored sacks each day

- At **1 week** of storage, 180kg of the 6 batches of coffee will be:
  - Sampled for m.c., A_w, mould and OTA contamination
  - Hulled wet and sun dried as green bean
  - Half the coffee from this batch will be dried to 17% m.c.
  - Half of this batch will be dried to 12% m.c.

- At **2 week** of storage the remaining 200kg of the 6 batches of coffee will be:
  - Sampled for m.c., Aw, mould and OTA contamination
  - Hulled wet and sun dried as green bean
  - Half the coffee from this batch will be dried to 17% m.c.
  - Half of this batch will be dried to 12% m.c.

- **Storage of dry coffee**: The 6 x 3 x 2 lots of green bean along with the 6 lots of previously dried parchment will be put into typical trader storage:
  - 12% and 17% m.c. coffee will all be shipped to Jember for the storage component of trial
  - 17% m.c. coffee will be stored for approximately 3 weeks and then dried to 12% m.c., then stored with original 12% m.c. coffee
  - These 42 lots will be sampled at 1 month, 3 months and 6 months of storage

- The trial will be conducted at Siborong-borong in North Sumatra, and Jember in East Java.

The following variables will be measured as and when described below:

- Moisture determined by oven drying
- Water activity (A_w)
- Fungal community
- OTA contamination

- Daily wet parchment coffee temperature in storage sack and warehouse temperature
- Cup quality and visual assessment of bean quality

4. SET UP

4.1 Materials for the trial

- Approx. 600kg x 6 sources fresh wet parchment
- Space to store wet parchment
- Tarpaulins and space suitable for drying (well drained and fully exposed to sun)
- Paper sacks capable of holding about 1kg of parchment

4.2 Sample and sample preparation

- Purchase 6 x 600kg of fresh wet parchment
- Mix each lot well and take samples as outlined in Section 5 to determine the initial condition of the Fresh wet parchment

4.2.1 Control preparation

- Select 40kg of wet parchment from each of the 6 lots
- Dry as normal parchment on tarpaulin to 12% moisture
- Select 180kg of wet parchment for hulling on Day 1 (fast process)

4.3 Storage of wet parchment

- Store the remaining 6 lots of 360kg of wet parchment in typical trade conditions - treat the wet parchment as a trader would treat it
- Take temperature readings at the centre of each sack daily
- After 1 week take a composite sample of 1kg from at least 10 places within the mass of each batch of coffee, then hull and dry 180kg of parchment (medium process)
- After 2 weeks take a composite sample of 1kg from at least 10 places within the mass of each batch of coffee, then hull and dry the remaining parchment of the 6 lots

4.4 Hulling of wet parchment

- Hull the wet parchment using the traditional system of a well-adjusted huller to minimize bean damage
- As soon as hulling is completed immediately dry to minimise mould production during this step

4.5 Drying

- Dry the 6 x 3 lots on tarpaulins in a similar manner
  - Half of each lot will be dried to 17% m.c. and put into storage
  - The other half of each lot will be dried to 12% moisture content
  - This will result in 6 x 3 x 2 = 36 lots
- Drying continues until each lot reaches 12% or 17% m.c.
  - The relevant samples of dry coffee are taken
- 17% m.c. coffee is stored for 3 weeks then dried to 12% m.c. and is ready for sampling and storage
- The coffee is ready for the long-term storage trial

4.6 Long Term Storage

- 42 lots in this storage trial will comprise of:
  - 6 x dry parchment lots
  - 6 x 3 one week wet storage lots, hulled then dried to 12% m.c.
  - 6 x 3 two week wet storage lots, hulled then dried to 17%, stored for 3 weeks and dried to 12% m.c.
- Label the 42 coffee bags and place them on a pallet in a storage facility similar to those used at trader level
- Storage will be conducted at ICCRI, Jember, East Java
- Sample for moisture content, A_w, cup quality, and mycological analysis as outlined below at 1 month, 3 month and 6 months intervals

5. SAMPLING

In this section, only sampling is described. Handling of these samples is described in the analysis section. Four sampling routines are indicated in this experiment:

- Initial sampling at set-up for establishing initial conditions
- Sampling during storage of wet parchment
- Sampling at the end of drying
- Sampling during storage

5.1 Initial sampling:

- Each of the 6 lots of fresh wet parchment should be well blended before sampling. Collect a composite sample from each lot comprising about 1kg of parchment gathered from 15 scattered points in the mass of coffee:
  - 200g from each will be used for oven moisture determination
  - 500g is to be prepared for OTA analysis
  - Part of the remaining 300g for mycological analysis (details below)

5.2 Sampling during storage of wet parchment:

- Week 1 and Week 2 (mycological, OTA, moisture measurement, A_w). Collect a sample comprising about 1kg of parchment gathered from 15 scattered points in the mass of coffee of each of 6 lots:
  - 200g from each will be used for oven moisture determination
  - 500g is to be prepared for OTA analysis
  - Part of the remaining 300g for mycological analysis (details below)
  - Check mould contamination and temperature of coffee daily

5.3 Sampling during drying of green bean:

- From about 25% moisture content:
  - Moisture measurements are to be made at the drying trays using a moisture meter.
  - This should be done before the beginning of drying (08.00h). Take a composite sample from several locations in the mass of parchment. Samples can be returned to the drying units.

5.4 Sampling at the end of drying of parchment control (after reaching 12%):

- Sample the dried parchment by taking a sample of about 1kg each from each experimental unit by gathering coffee from about ten different places in the tray;

- 200g from each will be used for oven moisture determination
- 500g is to be reserved for OTA analysis
- Part of the remaining 300g for mycological analysis (details below)
- A_w determination: once 12% moisture content is reached, fill a woven polythene bag with each replicate (6 lots). Label with treatment, date and replicate and prepare for storage trial.

5.5 Sampling at the end of drying of green bean (when experimental unit reaches 12% m.c.):

- Sample the dried product upon completion of the trial by taking a representative sample of about 2.5kg from each from each experimental unit by gathering coffee from about ten different places in the tray.
  - 200g from each will be used for oven moisture determination
  - 500g is to be reserved for OTA analysis
  - Part of the remaining 300g for mycological analysis (details below)
  - Part of the sample for cup tasting
- Note: 17% moisture coffee will be stored for 3 weeks and dried in Jember to 12%
- Once 12% moisture content is reached, fill a woven polythene bag with each replicate (36 lots). Label with treatment, date and replicate and prepare for storage trial.

5.6 Sampling during storage (in Jember):

- At 1 month of storage:
  - Take a representative sample of about 3.7kg from each bag by gathering coffee from about 20 different places in the bag
  - 2.5kg of each will be set aside for defect count and for cupping
  - 200g will be used for moisture determination and A_w
  - 500g will be ground for OTA analysis and the rest will be used for mycological study
- At 3 months of storage:
  - Take a representative sample of about 3.7kg from each bag by gathering coffee from about 20 different places in the bag
  - 2.5kg of each will be set aside for defect count and for cupping
  - 200g will be used for moisture determination and A_w
- After 6 months of storage:
  - Take a representative sample of about 3.7kg from each bag by gathering coffee from about 20 different places in the bag
  - 2.5kg of each will be set aside for defect count and for cupping,
  - 200g will be used for moisture determination
  - 500g will be ground for OTA analysis and the rest will be used for mycological study

6. <u>ANALYSIS</u>

6.1 Measurement of moisture by oven:

Working with an initial sample size of approximately 200g, record an accurate initial weight and put the sample in an oven to dry at 105°C for 24 hours. Cool the sample in a desiccator and weigh accurately. Replace the sample in the oven at 105°C for 4 hours, cool and reweigh. Repeat until 2 consecutive constant weights are obtained. Retain coded samples for reference and possible OTA analysis (see Section 6.4, below).

Record results in your data book and later enter them in the data recording sheets provided.

6.2 Weight of a constant volume:

If available, use a traditional receptacle with a minimum volume of 10l to weigh a constant volume. The receptacle must be of rigid construction, preferably metal or wood to avoid collapsing as could occur with a plastic bucket. The vessel should be twice as tall as wide to achieve the best reproducibility and must be agitated roughly to achieve settling. To load, stand the vessel in the frame and fill to over-flowing with a scoop. Agitate roughly to effect settling. Refill if necessary until coffee is proud of the plane of the vessel surface. Using a straight piece of wood longer than the maximum diameter of the vessel's opening, sweep off the excess cherry. Weigh and replace the cherry in the frame. Refill the vessel and take a second weight. Remove a sub-sample for the other measurements as described below.

6.3 Measurement of water activity during storage:

- During storage of green bean use a probe to measure A_w.
- Collect samples from the long-term stored coffee as described in sampling, Section 5. Seal the bag around the probe while minimizing the headspace in the bag. Record the A_w after one minute and re-check after 10 minutes, again at 12 minutes. Accept the value after 15 minutes if a steady value has been reached, or allow another 5 minutes if necessary. Dryer samples may reach steady state more quickly and wetter samples may require a longer period to reach a steady state. Record the steady value and the temperature at which the water activity reading was taken, first in your data book and later in the excel data sheet provided. Remember to return the sample to the mass of coffee of the appropriate experimental unit.

6.4 Microbiological analysis:

Initial readings:

Analyse samples by the *x* + *m* and *i* method as derived from procedures in the project mycological handbook. This is done by skipping the initial washing and external disinfection steps of 'three-part' analysis and separating the parchments from the pulps in the first step. Use only one bean from each cherry in the analysis, discarding the other (if two or three are present). The pulps are stomached in the usual way but since no disinfection has been conducted, the supernatant contains both communities. Set up more replicates than specified in the handbook: *i*-analysis, 14 plates ; *x* + *m*-analysis, 5 plates at each dilution.

Final readings:

The microbiological analysis should be completed as soon as possible but within one month while keeping the samples in paper bags in dry ambient conditions. Conduct only *i*-analysis but use 20 plates or 140 beans. Since it is not practical to open dried beans one-at-a-time to ensure no double analysis of cherries takes place, dehusk 500g of the 1kg sample and randomly separate the required sample (ca. 140 beans) for analysis.

6.5 OTA analysis

Initial value:

A separate drying regime is to be applied in preparing samples for OTA analysis in the initial sampling. The samples from each of the treatment/replicate combinations should

be dried in an oven in a monolayer at $60^{O}C$. To avoid any risk of re-hydration and secondary contamination, oven dried coffee must be kept in a sealed small plastic bag (do not forget to label the sample, best done on a paper label written in pencil placed in each bag).

Samples taken immediately after production of wet parchment should prepared for OTA analysis as outlined above, but not sent for analysis unless any of the 'control' samples are found to contain OTA.

Final value:
No further drying is required once the experiment has been completed and 12% moisture content is reached, however, naturally dried coffee, since it has a higher moisture content, should be held in paper until either analysed or re-packed in plastic for transportation to the analyst. An accompanying note should be included to indicate the moisture content of the samples and a request for rapid action.

6.6 Cup testing

Take samples of beans from each experimental unit for cupping (according to standard procedure) and visual assessment of bean quality.

ANNEX 2

CUP TASTING INSTRUCTIONS TO TASTERS

FAO/ICCRI MANDHELING COFFEE PROCESSING TRIAL

General Notes for Sample Evaluation:

Coffee has been collected from **6 places** in North Sumatra. The coffee from each of these sources is processed **7 different ways**, in an effort to replicate some of the possible local processing techniques. The result is **42 samples** of coffee.

1. **Individuals samples** are assessed by Standard SCAA / Lingle quality criteria, along with a 'Mandheling Character' rating and a 'DP/TP Character' rating.
    a. **Form 1** can be used to evaluate each individual sample.

2. **Groups of coffee samples** may show common trends or flavour characteristics when the odd or extreme flavours in some samples have been excluded.
    a. There are **7 process groups** (6 coffee samples in each)
    b. There are **6 source groups** (7 coffee samples in each)
    c. The 42 coffee samples are evaluated in 2 ways, by grouping samples in **2 sub-sets** to determine if flavour characteristics demonstrated in groups are related to the:
        i. Processing regimes
        ii. Location factors

3. **Flavour definitions:**
    a. Use tasting criteria in 'The Coffee Cuppers Hand Book', by Ted Lingle for the basic 'Standardised' evaluation of each individual sample.
    b. Coffee shipped from the Port of Medan is often described as 1 of 2 flavour character types:
        i. The **'Mandheling character'** which is a spicy, earthy coffee with heavy body and little or no acidity.
        ii. The **'DP/TP character'** is the Dry Process/Triple Pick coffee with good body, low acidity but sweeter, cleaner and less earthy than the Mandheling character.

ANNEX 3

Table 1 - Cup Taste Evaluation Forms for Taster 1
Evaluation form for FAO/ICCRI Mandheling Coffee Processing Trial

TASTER 1		FORM 1 : Individual Samples										
			SCAA / Lingle Tasting Criteria							Mandheling	DP / TP	Specific Coffee
Source	Process	Sample No.	Fragrance	Acidity	Flavour	Body	After Taste	Cupper's Point	Total Score	Character	Character	Sample Comments
			1 - 10	1 - 10	1 - 10	1 - 10	1 - 10	-5 to +5	100 pts	1 to 10	1 to 10	(nc = no comments given)
A	M	**1**	7	8	5	6	6	-5	***77***	1	5	Very Acid
A	L	**2**	8	2	7	7	7	-5	***76***	10	5	Musty
A	K	**3**	6	3	6	5	6	2	***78***	5	7	Musty less
A	J	**4**	3	3	2	4	2	-3	***61***	1	4	Medicinal
A	I	**5**	1	1	1	4	1	-5	***53***	1	1	Fruity ferment
A	H	**6**	5	8	5	4	5	-2	***75***	1	3	Acidic
A	G	**7**	2	2	2	6	2	-5	***59***	3	5	Dirty,Medic
B	M	**8**	6	3	3	3	4	1	***70***	1	3	Too Clean
B	L	**9**	6	1	7	8	7	-3	***76***	8	2	Musty
B	K	**10**	6	1	7	8	7	-3	***76***	8	2	Musty metalic
B	J	**11**	5	3	6	7	7	3	***81***	4	7	nc
B	I	**12**	5	6	2	4	2	-5	***64***	3	5	Fruity
B	H	**13**	7	1	7	8	7	4	***84***	8	4	nc
B	G	**14**	6	4	4	6	4	0	***74***	3	6	nc
C	M	**15**	6	5	6	6	7	1	***81***	2	7	nc
C	L	**16**	3	3	4	4	4	-2	***66***	6	5	Peanutty, paper
C	K	**17**	4	2	6	6	5	0	***73***	5	6	Paper
C	J	**18**	5	3	3	6	3	-1	***69***	4	6	Paper
C	I	**19**	4	6	4	4	3	-3	***68***	2	6	Fruity, sour
C	H	**20**	6	2	6	7	7	3	***81***	5	7	Sweet
C	G	**21**	3	1	7	8	7	4	***80***	7	4	Paper
D	M	**22**	7	3	3	5	4	-3	***69***	2	2	Defect metal
D	L	**23**	8	4	2	5	2	-4	***67***	3	5	Sour musty harsh dirty

TASTER 1		FORM 1 : Individual Samples										
			SCAA / Lingle Tasting Criteria							Mandheling	DP / TP	Specific Coffee
Source	Process	Sample No.	Fragrance	Acidity	Flavour	Body	After Taste	Cupper's Point	Total Score	Character	Character	Sample Comments
			1 - 10	1 - 10	1 - 10	1 - 10	1 - 10	-5 to +5	100 pts	1 to 10	1 to 10	(nc = no comments given)
D	K	**24**	2	6	1	6	1	-5	***61***	1	1	Fruity full ferment
D	J	**25**	3	7	4	4	5	0	***73***	1	7	Paper
D	I	**26**	5	4	3	6	4	-1	***71***	3	5	Paper
D	H	**27**	4	4	3	6	4	0	***71***	3	6	Paper
D	G	**28**	7	3	5	6	6	1	***78***	5	6	Slight paper
E	M	**29**	5	4	5	4	6	2	***76***	2	4	Slight paper
E	L	**30**	8	4	3	5	3	-2	***71***	5	5	Musty
E	K	**31**	3	5	6	5	6	2	***77***	6	4	Paper
E	J	**32**	7	1	6	7	6	2	***79***	6	4	Musty
E	I	**33**	3	4	2	6	2	-3	***64***	2	5	Fruity
E	H	**34**	3	7	4	5	4	-2	***71***	2	6	Sour
E	G	**35**	4	2	5	6	5	0	***72***	3	6	Papery
F	M	**36**	3	3	1	4	1	-4	***58***	1	1	metalic Dirty
F	L	**37**	4	2	4	6	5	1	***72***	4	7	Musty
F	K	**38**	5	1	5	7	6	1	***75***	5	5	Off flavour
F	J	**39**	4	4	5	5	6	2	***76***	2	7	nc
F	I	**40**	1	7	3	4	2	-3	***64***	2	6	Sour
F	H	**41**	2	4	5	6	3	-1	***69***	2	6	Astringent Dry slight Musty
F	G	**42**	5	5	4	6	5	2	***77***	2	6	Slight musty bitter taste

Notes: Adjusted sample No 1 Mandheling score from -5 to 1 and sample No 8 Mandheling score from 0 to 1.

Table 2 - Cup Taste Evaluation Forms for Taster 2
Evaluation form for FAO/ICCRI Mandheling Coffee Processing Trial

TASTER 2		FORM 1 : Individual Samples										
			SCAA / Lingle Tasting Criteria							Mandheling	DP / TP	Specific Coffee
Source	Process	Sample No.	Fragrance	Acidity	Flavour	Body	After Taste	Cupper's Point	Total Score	Character	Character	Sample Comments
			1 - 10	1 - 10	1 - 10	1 - 10	1 - 10	-5 to +5	100 pts	1 to 10	1 to 10	(nc = no comments given)
A	M	1	No comments given for SCAA tasting criteria							1.4	No scores given	Medium body, some slight dusty
A	L	2								8.6		Medium body, round, some herbals
A	K	3								5.7		Medium mild body, earthy flavor, slight inconsistent
A	J	4								7.5		Medium body, herbals, earthy character
A	I	5								1.4		Fermented
A	H	6								2.9		Sharp, dry finish
A	G	7								1.4		Medium body, inconsistent, slightly sharp
B	M	8								5.7		Some acidity, medium body,some earthy character
B	L	9								10.0		Medium body, round, nice herbals
B	K	10								4.3		Medium body, some nice herbals, slight dry finish
B	J	11								4.3		Medium body, slight herbals but one-dimensional flavor
B	I	12								1.4		Fruity
B	H	13								2.9		Slight acidity, greenish flavor
B	G	14								1.4		Slight acidity, medium body, very slight fruity flavor inconsistent
C	M	15								1.4		Medium body, rough un-elegant flavor

TASTER 2		FORM 1 : Individual Samples										
			SCAA / Lingle Tasting Criteria							Mandheling	DP / TP	Specific Coffee
Source	Process	Sample No.	Fragrance	Acidity	Flavour	Body	After Taste	Cupper's Point	Total Score	Character	Character	Sample Comments
			1 - 10	1 - 10	1 - 10	1 - 10	1 - 10	-5 to +5	100 pts	1 to 10	1 to 10	(nc = no comments given)
C	L	16	No comments given for SCAA tasting criteria							2.9	No scores given	Medium body, some slight herbals character, dry oldish finish
C	K	17								2.9		Thin body, neutral flavor
C	J	18								1.4		1/3 frmented, rest rough finish, one-dimensional flavor
C	I	19								1.4		Fruity, rough finish
C	H	20								1.4		Thin , dry, rough finish
C	G	21								4.3		Medium body, very slightly thin, very slighlty herbals
D	M	22								2.9		Medium mild acidity, slightly sharp finish
D	L	23								4.3		Some herbals, very slight astringent, thin in body
D	K	24								1.4		Medium body, fruity flavor, background herbals,
D	J	25								2.9		Thin body, one-dimensional flavor
D	I	26								1.4		Mild acidity, medium body, very rough, dry finish
D	H	27								2.9		One-dimensional flavor, dry finish
D	G	28								1.4		Slightly fruity, rough finish
E	M	29								2.9		Medium body, one-dimensional flavor
E	L	30								2.9		Medium body, one-dimensional flavor
E	K	31								2.9		Thin in body and flavor
E	J	32								2.9		Medium body, one-dimensional flavor
E	I	33								1.4		Slightly fruity throughout
E	H	34								1.4		Medium body, sharp finish

TASTER 2		FORM 1 : Individual Samples										
			SCAA / Lingle Tasting Criteria							Mandheling	DP / TP	Specific Coffee
Source	Process	Sample No.	Fragrance	Acidity	Flavour	Body	After Taste	Cupper's Point	Total Score	Character	Character	Sample Comments
			1 - 10	1 - 10	1 - 10	1 - 10	1 - 10	-5 to +5	100 pts	1 to 10	1 to 10	(nc = no comments given)
E	G	35	No comments given for SCAA tasting criteria							1.4	No scores given	Medium body, one-dimensional flavor, background fruity
F	M	36								2.9		Flat, neutral cups
F	L	37								2.9		Medium body, one-dimensional flavor
F	K	38								2.9		Medium body, slightly one-dimensional flavor
F	J	39								1.4		Medium body, one-dimensional flavor, 1 cup dirty
F	I	40								1.4		Medium body, slight herbals background fruity
F	H	41								2.9		Medium body, one-dimensional flavor
F	G	42								5.7		Medium body, one-dimensional, some ok flavor

Notes: Mandheling rating originally given from 1 to 7, and converted here to a scale of 1 to 10 for ease of comparison with other scores.

Table 3 - Cup Taste Evaluation Forms for Taster 3
Evaluation form for FAO/ICCRI Mandheling Coffee Processing Trial

TASTER 3		FORM 1 : Individual Samples										
			SCAA / Lingle Tasting Criteria							Mandheling	DP / TP	Specific Coffee
Source	Process	Sample No.	Fragrance	Acidity	Flavour	Body	After Taste	Cupper's Point	Total Score	Character	Character	Sample Comments
			1 - 10	1 - 10	1 - 10	1 - 10	1 - 10	-5 to +5	100 pts	1 to 10	1 to 10	(nc = no comments given)
A	M	**1**	5.5	4.3	5.0	5.7	4.3	2.0	***77***	6.0	4.3	nc
A	L	**2**	4.0	5.3	5	5.3	4.3	1.0	***75***	6.7	3.7	nc
A	K	**3**	7.0	6.7	5.0	5.0	5.0	1.0	***80***	5.3	6.5	Aroma: Chocolate
A	J	**4**	5.5	7.0	4.7	4.3	4.5	-2.5	***74***	2.3	4.7	Too acid, sour
A	I	**5**	7.0	6.0	5.0	5.0	5.0	-1.0	***77***	5.0	5.3	Aroma: Chocolate
A	H	**6**	5.5	5.3	5.0	5.7	3.7	-1.0	***74***	4.3	4.0	nc
A	G	**7**	5.0	5.7	4.7	4.3	4.5	-0.5	***74***	3.5	5.0	A bit sour
B	M	**8**	5.5	7.3	4.7	4.0	4.0	-0.6	***75***	3.7	6.0	nc
B	L	**9**	6.0	6.0	4.0	4.5	5.0	1.5	***77***	6.0	3.7	Good taste, body clean
B	K	**10**	8.0	6.0	5.0	4.3	4.7	1.0	***79***	5.0	6.5	Aroma: Chocolate, spice
B	J	**11**	5.5	7.0	4.0	3.3	5.0	-3.0	***72***	2.0	4.3	Sour
B	I	**12**	5.5	4.7	5.0	5.3	5.0	1.0	***77***	6.0	4.0	nc
B	H	**13**	6.0	4.7	5.0	5.7	3.7	-1.0	***74***	5.0	3.7	nc
B	G	**14**	5.0	5.3	5.0	4.3	4.5	0.0	***74***	4.0	5.5	nc
C	M	**15**	5.5	4.7	4.3	4.7	4.0	-1.5	***72***	5.3	3.3	nc
C	L	**16**	6.0	6.3	5.0	4.7	4.0	0.0	***76***	5.7	3.7	Sour Earthy
C	K	**17**	7.0	4.0	5.0	5.7	5.0	1.0	***78***	5.7	4.7	nc
C	J	**18**	5.5	6.3	4.7	4.3	5.0	-2.5	***73***	3.0	5.3	Tea flavour
C	I	**19**	5.5	5.7	4.7	4.3	4.7	-1.0	***74***	4.3	5.3	nc
C	H	**20**	6.0	4.3	5.3	5.7	4.3	1.0	***77***	5.7	3.7	nc
C	G	**21**	4.5	4.7	5.7	5.7	5.5	1.0	***77***	5.5	4.5	Good Balance
D	M	**22**	5.5	3.3	5.0	5.3	4.3	0.6	***74***	6.3	3.0	nc
D	L	**23**	6.0	6.3	4.0	4.7	3.3	-1.7	***73***	5.3	3.0	Baggy dirty

TASTER 3		FORM 1 : Individual Samples										
			SCAA / Lingle Tasting Criteria							Mandheling	DP / TP	Specific Coffee
Source	Process	Sample No.	Fragrance	Acidity	Flavour	Body	After Taste	Cupper's Point	Total Score	Character	Character	Sample Comments
			1 - 10	1 - 10	1 - 10	1 - 10	1 - 10	-5 to +5	100 pts	1 to 10	1 to 10	(nc = no comments given)
D	K	**24**	5.0	6.0	4.5	4.5	4.5	-3.0	***72***	4.0	4.0	Fermented
D	J	**25**	5.5	7.3	3.7	3.0	3.5	-2.0	***71***	2.3	4.0	Sour
D	I	**26**	5.5	6.0	4.0	4.3	4.0	-1.0	***73***	3.7	5.0	Tea flavour
D	H	**27**	6.0	4.7	5.7	6.3	5.7	1.0	***79***	6.3	4.3	nc
D	G	**28**	4.0	4.3	5.0	5.7	4.0	0.0	***73***	5.5	3.5	Dirty
E	M	**29**	5.5	7.0	4.3	4.0	3.7	-0.3	***74***	2.7	6.3	nc
E	L	**30**	4.0	6.7	4.7	5.0	4.0	0.0	***74***	5.7	3.3	nc
E	K	**31**	5.0	4.7	5.3	5.3	5.3	1.0	***77***	6.0	5.3	nc
E	J	**32**	5.5	7.0	5.0	4.3	5.5	-1.0	***76***	2.0	4.3	Sour Green taste
E	I	**33**	5.0	5.3	4.7	5.7	4.0	1.0	***76***	5.3	5.3	Aroma: less intense
E	H	**34**	6.0	4.3	5.3	6.0	5.3	1.0	***78***	6.3	4.7	nc
E	G	**35**	5.5	4.7	5.0	6.3	4.5	0.0	***76***	6.0	3.5	Dirty
F	M	**36**	5.5	4.3	4.7	5.0	5.0	1.0	***76***	5.7	4.5	Less acidity when cool
F	L	**37**	7.0	5.3	6.0	5.3	5.0	0.7	***79***	5.0	5.0	Good Flavour, a bit smokey
F	K	**38**	5.0	5.0	5.3	5.7	4.7	1.0	***77***	6.0	4.3	nc
F	J	**39**	5.5	6.0	4.3	5.0	4.0	0.0	***75***	3.3	4.0	nc
F	I	**40**	6.5	5.7	4.7	5.3	5.0	1.5	***79***	6.0	4.7	Aroma: Chocolate
F	H	**41**	6.0	4.3	4.7	5.7	4.7	1.0	***76***	5.7	4.3	nc
F	G	**42**	5.5	4.7	5.0	5.7	5.0	1.0	***77***	5.0	4.5	nc

Table 4 - Cup Taste Evaluation Forms for Taster 4
Evaluation form for FAO/ICCRI Mandheling Coffee Processing Trial

TASTER 3		FORM 1 : Individual Samples										
			SCAA / Lingle Tasting Criteria							Mandheling	DP / TP	Specific Coffee
Source	Process	Sample No.	Fragrance	Acidity	Flavour	Body	After Taste	Cupper's Point	Total Score	Character	Character	Sample Comments
			1 - 10	1 - 10	1 - 10	1 - 10	1 - 10	-5 to +5	100 pts	1 to 10	1 to 10	(nc = no comments given)
A	M	**1**	3	2	3	3	3	1	*64*	3	3	nc
A	L	**2**	3	4	3	4	3	1	*68*	3	3	nc
A	K	**3**	3	3	3	5	2	1	*67*	3	2	nc
A	J	**4**	4	4	3	4	3	2	*70*	4	2	nc
A	I	**5**	3	4	3	4	3	2	*68*	3	3	All cups slightly fermented
A	H	**6**	3	4	4	4	4	3	*71*	4	3	nc
A	G	**7**	4	4	3	4	3	3	*71*	4	2	nc
B	M	**8**	5	3	4	5	4	2	*71*	4	4	Fair cup
B	L	**9**	3	4	3	3	3	1	*67*	3	3	All cups slightly baggy
B	K	**10**	3	4	4	4	3	1	*70*	4	3	nc
B	J	**11**	4	4	4	4	4	2	*72*	4	3	Pleasant
B	I	**12**	4	3	3	4	2	1	*67*	3	3	Unpleasant
B	H	**13**	3	4	4	4	3	2	*71*	3	3	nc
B	G	**14**	5	3	3	4	3	1	*70*	3	3	All cups slightly fermented
C	M	**15**	3	4	3	4	2	0	*66*	3	3	nc
C	L	**16**	3	4	3	4	3	1	*68*	4	3	nc
C	K	**17**	3	5	3	4	3	2	*68*	4	3	nc
C	J	**18**	3	3	3	4	3	2	*68*	4	3	nc
C	I	**19**	4	3	3	4	3	1	*68*	4	2	Thin
C	H	**20**	4	3	4	4	4	2	*70*	4	3	nc
C	G	**21**	5	4	4	4	4	3	*74*	5	3	Pleasant
D	M	**22**	4	4	3	4	3	1	*68*	4	3	nc
D	L	**23**	4	5	4	4	4	3	*74*	4	3	nc

TASTER 3		FORM 1 : Individual Samples										
			SCAA / Lingle Tasting Criteria							Mandheling	DP / TP	Specific Coffee
Source	Process	Sample No.	Fragrance	Acidity	Flavour	Body	After Taste	Cupper's Point	Total Score	Character	Character	Sample Comments
			1 - 10	1 - 10	1 - 10	1 - 10	1 - 10	-5 to +5	100 pts	1 to 10	1 to 10	(nc = no comments given)
D	K	**24**	4	3	4	4	3	1	*69*	3	3	Unpleasant
D	J	**25**	4	4	4	5	4	2	*72*	5	3	Slightly sweet
D	I	**26**	4	3	4	4	3	1	*69*	4	3	Unpleasant
D	H	**27**	4	4	3	4	2	1	*68*	4	2	nc
D	G	**28**	4	4	3	4	2	0	*67*	4	2	1 cup chemical
E	M	**29**	4	4	3	4	3	1	*70*	4	3	Astringent
E	L	**30**	4	4	3	4	3	1	*69*	4	3	nc
E	K	**31**	4	5	4	4	3	0	*70*	4	3	nc
E	J	**32**	4	5	4	5	4	2	*74*	5	3	nc
E	I	**33**	4	3	3	5	3	0	*68*	4	3	All cups slightly fermented
E	H	**34**	4	4	3	4	3	1	*69*	4	3	nc
E	G	**35**	4	4	3	4	3	2	*70*	4	3	nc
F	M	**36**	4	2	2	4	2	0	*63*	4	3	nc
F	L	**37**	4	4	3	5	2	0	*68*	4	2	nc
F	K	**38**	4	3	3	4	2	0	*65*	4	3	nc
F	J	**39**	4	4	3	4	2	2	*69*	5	3	nc
F	I	**40**	3	4	3	4	4	0	*68*	4	3	All cups slightly fermented
F	H	**41**	3	4	3	5	3	1	*68*	4	2	nc
F	G	**42**	5	5	4	5	4	2	*74*	5	3	Nice & pleasant

Table 5 - Coffee Source / Starting m.c., A_w, Temp / Notes on wet storage

Source	Origin	m.c. (%)	A_w	Temp (°C)
Lot I A	Parik Sabungan, Sub-district Siborong-borong, District North Tapanuli	42.21	0.921	21.5
Lot II B	Sipintu-pintu, Sub-district Siborong-borong, District North Tapanuli	45.55	0.927	21.6
Lot III C	Silando/Sianjur, Sub-district Siborong-borong, District North Tapanuli	41.74	0.929	21.6
Lot IV D	Tangga Batu, Sub-district Balige, District Toba Samosir	44.58	0.926	21.8
Lot V E	Silangit, Sub-district Siborong-borong, District North Tapanuli	44.15	0.916	21.6
Lot VI F	Parsoburan, Sub-district Parsoburan, District Toba Samosir	48.96	0.912	21.7

Notes on Storage of Wet Parchment

Day1	Coffee looks normal
Day2	Coffee normal
Day3	Mould visually start growing on naked and broken coffee beans of Lot VI
Day4	Mould visually start growing on naked and broken coffee beans of Lot I and VI
Day5	Mould visually start growing on naked and broken coffee beans of Lot I and VI; black spots on surface of parchment
Day 6	Black spots on all lots start to grow
Day7	Black spots on all lots more intensive
Day8	All lots spread on tarpaulin inside the warehouse only during the day, and put back in the sack in the afternoon
Day9	The same as the day before, to suppress the mould grow
Day10	The same as the day before
Day11	The same as the day before
Day12	The same as the day before
Day13	The same as the day before
Day14	The same as the day before, the spots seem not too excessive only broken beans covered by mould

Table 6 - A_w of parchment during 14 days storage

A_w of parchments

	Day													
Lot	0	1	2	3	4	5	6	7	8	9	10	11	13	14
I	0.912	0.903	0.915	0.951	0.934	0.939	0.937	0.922	0.922	0.915	0.905	0.888	0.912	0.918
II	0.927	0.897	0.919	0.949	0.93	0.942	0.934	0.917	0.924	0.917	0.909	0.897	0.914	0.92
III	0.929	0.908	0.911	0.937	0.92	0.936	0.924	0.914	0.922	0.92	0.912	0.898	0.915	0.929
IV	0.926	0.89	0.911	0.938	0.925	0.945	0.93	0.934	0.923	0.922	0.912	0.899	0.902	0.928
V	0.916	0.911	0.911	0.928	0.911	0.934	0.916	0.907	0.922	0.925	0.91	0.899	0.911	0.924
VI	0.912	0.915	0.925	0.939	0.907	0.935	0.919	0.916	0.921	0.927	0.907	0.9	0.906	0.928

Temperature of parchments (°C)

	Day													
Lot	0	1	2	3	4	5	6	7	8	9	10	11	13	14
I	21.5	21.8	34.3	30.5	28.2	26.9	26.8	26.5	24.7	22.5	25.7	23.9	22.9	23.4
II	21.6	21.9	34.8	32	29.3	29	28.2	26.8	24.8	22.5	25.8	23.9	23	23.8
III	21.6	22.2	35	30.1	27.3	27.1	26.9	26.9	24.7	22.5	26.1	23.9	23.2	25.5
IV	21.8	22.6	34.2	32	30.5	31.3	31.3	27.6	24.9	22.5	26.3	24	22.9	26
V	21.6	22.7	34.8	31.7	30.1	29.3	29	28.3	25.1	22.5	26.2	24.1	23.3	25.6
VI	21.7	21.9	34.9	34.9	30.5	30.2	30.2	29.1	25.1	22.8	26.1	24.2	22.8	26

Ambient (warehouse)

	Day													
Lot	0	1	2	3	4	5	6	7	8	9	10	11	13	14
A_w of ambient	0.905	0.911	0.894	0.819	0.823	0.8	0.791	0.79	0.775	0.786	0.723	0.921	0.888	0.782
Temperature of ambient (°C)	25.3	25.9	24.2	22.3	21.9	21.7	23.4	25	21.8	20.5	24.1	18.3	20.7	22.2

Table 7 - Mycological analysis of 6 wet parchment sources stored over 14 days

No	Source and Sample code	% Moulded beans					
		Black aspergilli	Flavi	Ochra	Penicillium	Yeast	Other species
1	D1 (day 1) I	0	0	0	0	4.08	20.41
2	D1 (day 1) II	4.08	1.02	0	0	1.02	1.02
3	D1 (day 1) III	0	0	0	0	0	1.02
4	D1 (day 1) IV	0	0	0	0	4.08	10.2
5	D1 (day 1) V	0	0	0	0	4.08	13.27
6	D1 (day 1) VI	2.04	0	0	2.04	0	44.9
7	D7 (day 7) I	42.86	35.71	0	33.67	0	4.08
8	D7 (day 7) II	96.94	87.76	0	0	0	30.61
9	D7 (day 7) III	26.53	40.82	0	6.12	11.22	17.05
10	D7 (day 7) IV	21.43	20.41	0	2.04	0	64.28
11	D7 (day 7) V	22.45	7.14	0	69.39	1.02	78.57
12	D7 (day 7) VI	45.92	8.16	0	21.43	0	61.23
13	D14 (day 14) I	64.29	36.73	0	11.22	0	42.85
14	D14 (day 14) II	95.92	67.35	2.04	4.08	7.14	40.81
15	D14 (day 14) III	63.26	48.99	5.1	8.16	4.08	45.91
16	D14 (day 14) IV	57.14	41.84	7.14	1.02	0	53.06
17	D14 (day 14) V	87.76	25.51	4.08	8.16	0	44.89
18	D14 (day 13) VI	86.73	16.33	1.02	6.12	0	46.93

Table 8 - Mycology of green bean compared to blind cup tasting comments

Source	Process	Sample No.	Mycological Results of Dry (12%) Green Bean						OTA (ppb)	Taster 2	Taster 4	Taster 1	Taster 2
			Black aspergilli	Flavi	Ochra	Penicillium	Yeast	Other species		Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)
A	M	**1**	57.39	13.27	0	4.08	0	22.45	0.00	Medium body, some slight dusty	nc	Very Acid	nc
A	L	**2**	35.71	17.35	0	5.1	0	18.37	0.00	Medium body, round, some herbals	nc	Musty	nc
A	K	**3**	21.43	2.04	0	3.06	17.35	0	0.00	Medium mild body, earthy flavor, slight inconsistent	nc	Musty less	Aroma: Chocolate
A	J	**4**	69.39	30.61	0	5.1	0	13.26	0.00	Medium body, herbals, earthy character	nc	Medicinal	Too acid, sour
A	I	**5**	72.45	23.47	0	7.14	2.04	21.43	0.00	Fermented	All cups slightly fermented	Fruity ferment	Aroma: Chocolate
A	H	**6**	45.92	43.88	0	3.06	0	13.26	0.00	Sharp, dry finish	nc	Acidic	nc
A	G	**7**	83.67	38.67	0	21.43	0	28.57	0.00	Medium body, inconsistent, slightly sharp	nc	Dirty,Medic	A bit sour
B	M	**8**	57.14	7.14	1.02	7.14	0	13.26	0.00	Some acidity, medium body,some earthy character	Fair cup	Too Clean	nc
B	L	**9**	58.16	3.06	0	1.02	0	2.04	0.00	Medium body, round, nice herbals	All cups slightly baggy	Musty	Good taste, body clean

Source	Process	Sample No.	Mycological Results of Dry (12%) Green Bean						OTA (ppb)	Taster 2	Taster 4	Taster 1	Taster 2
			Black aspergilli	Flavi	Ochra	Penicillium	Yeast	Other species		Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)
B	K	**10**	21.43	2.04	0	2.04	3.06	12.08	0.00	Medium body, some nice herbals, slight dry finish	nc	Musty metalic	Aroma: Chocolate, spice
B	J	**11**	82.65	43.88	0	9.18	0	17.34	0.00	Medium body, slight herbals but one-dimensional flavor	Pleasant	nc	Sour
B	I	**12**	80.61	40.82	0	14.29	0	9.18	0.00	Fruity	Unpleasant	fruity	nc
B	H	**13**	61.22	36.73	0	7.14	0	24.49	0.00	Slight acidity, greenish flavor	nc	nc	nc
B	G	**14**	94.9	41.84	1.02	15.31	0	19.38	0.00	Slight acidity, medium body, very slight fruity flavor inconsistent	All cups slightly fermented	nc	nc
C	M	**15**	11.22	3.06	0	13.27	1.02	2.04	0.00	Medium body, rough un-elegant flavor	nc	nc	nc
C	L	**16**	21.43	6.12	0	2.04	17.35	7.14	0.00	Medium body, some slight herbals character, dry oldish finish	nc	Peanutty, paper	Sour Earthy
C	K	**17**	24.49	17.35	0	7.14	1.02	10.2	0.00	Thin body, neutral flavor	nc	Paper	nc
C	J	**18**	52.04	24.49	1.02	7.14	0	14.28	0.00	1/3 fermented, rest rough finish, one-dimensional flavor	nc	Paper	Tea flavour
C	I	**19**	22.45	11.22	0	12.24	1.02	27.54	0.00	Fruity, rough finish	Thin	Fruity, sour	nc

Source	Process	Sample No.	Mycological Results of Dry (12%) Green Bean						OTA (ppb)	Taster 2	Taster 4	Taster 1	Taster 2
			Black aspergilli	Flavi	Ochra	Penicillium	Yeast	Other species		Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)
C	H	**20**	82.65	47.96	2.04	8.16	0	17.35	1.80	Thin , dry, rough finish	nc	Sweet	nc
C	G	**21**	82.65	37.76	6.12	23.47	0	22.44	0.00	Medium body, very slightly thin, very slightly herbals	Pleasant	Paper	Good Balance
D	M	**22**	47.96	15.31	1.02	8.16	0	29.6	0.00	Medium mild acidity, slightly sharp finish	nc	Defect metal	nc
D	L	**23**	78.57	22.45	3.06	0	0	24.49	0.00	Some herbals, very slight astringent, thin in body	nc	Sour musty harsh dirty	Baggy dirty
D	K	**24**	50.02	6.12	1.02	40.82	0	14.28	0.00	Medium body, fruity flavor, background herbals,	Unpleasant	Fruity full ferment	Fermented
D	J	**25**	74.49	24.49	0	0	0	34.69	0.00	Thin body, one-dimensional flavor	Slightly sweet	Paper	Sour
D	I	**26**	63.27	9.18	1.02	11.22	0	40.81	0.00	Mild acidity, medium body, very rough, dry finish	Unpleasant	Paper	Tea flavour
D	H	**27**	77.55	22.45	2.04	2.04	0	31.63	0.07	One-dimensional flavor, dry finish	nc	Paper	nc
D	G	**28**	96.94	25.51	7.14	6.12	0	67.34	0.00	Slightly fruity, rough finish	1 cup chemical	Slight paper	Dirty
E	M	**29**	28.57	9.18	0	13.27	0	14.28	0.79	Medium body, one-dimensional flavor	Astringent	Slight paper	nc

Source	Process	Sample No.	Mycological Results of Dry (12%) Green Bean						OTA (ppb)	Taster 2	Taster 4	Taster 1	Taster 2
			Black aspergilli	Flavi	Ochra	Penicillium	Yeast	Other species		Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)
E	L	**30**	62.24	27.55	2.04	4.08	0	30.61	0.07	Medium body, one-dimensional flavor	nc	Musty	nc
E	K	**31**	20.41	5.1	0	1.02	0	10.2	0.00	Thin in body and flavor	nc	Paper	nc
E	J	**32**	80.61	20.41	1.02	9.18	0	20.59	0.00	Medium body, one-dimensional flavor	nc	Musty	Sour Green taste
E	I	**33**	63.27	12.24	1.02	7.14	0	34.7	0.00	Slightly fruity throughout	All cups slightly fermented	Fruity	Aroma: less intense
E	H	**34**	77.55	12.24	4.08	6.12	0	25.51	2.24	Medium body, sharp finish	nc	Sour	nc
E	G	**35**	85.71	34.69	15.31	41.84	0	41.84	0.17	Medium body, one-dimensional flavor, background fruity	nc	Papery	Dirty
F	M	**36**	74.49	17.35	0	3.06	2.04	50	0.73	Flat, neutral cups	nc	Metallic Dirty	Less acidity when cool
F	L	**37**	53.06	36.73	1.02	7.14	5.1	15.31	0.00	Medium body, one-dimensional flavor	nc	Musty	Good Flavour, a bit smokey
F	K	**38**	54.08	10.2	0	11.22	0	17.24	0.00	Medium body, slightly one-dimensional flavor	nc	Off flavour	nc
F	J	**39**	79.59	22.45	1.02	2.04	0	45.92	0.00	Medium body, one-dimensional flavor, 1 cup dirty	nc	nc	nc
F	I	**40**	77.55	29.59	7.14	3.06	0	25.51	0.00	Medium body, slight herbals background fruity	All cups slightly fermented	Sour	Aroma: Chocolate

Source	Process	Sample No.	Mycological Results of Dry (12%) Green Bean						OTA (ppb)	Taster 2	Taster 4	Taster 1	Taster 2
			Black aspergilli	Flavi	Ochra	Penicillium	Yeast	Other species		Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)	Specific Sample Comments (nc = no comments given)
F	H	**41**	67.35	21.43	0	5.1	0	37.75	0.00	Medium body, one-dimensional flavor	nc	Astringent Dry slight Musty	nc
F	G	**42**	89.8	18.37	4.08	4.08	0	37.75	0.00	Medium body, one-dimensional, some ok flavor	Nice & pleasant	Slight musty bitter taste	nc