

# Link between volatile composition of cocoa beans and the use of yeast starter cultures during fermentation

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## Context

Cocoa quality derives strongly from its flavor and its flavor precursor composition. Both, volatile and non-volatile compounds contribute to the final flavor perception of cocoa [1].

Among post-harvest processes, fermentation has arguably the most significant impact on the formation of volatiles, as well as their precursors. Some of these will then be further transformed during roasting by means of Maillard reaction and Strecker degradation [2].

Fermentation of cocoa beans involves an initial anaerobic phase, driven by yeasts and lactic acid bacteria. Followed by an aerobic phase, where acetic acid bacteria are predominant.

This work focuses on the study of the impact of fermentation time and of the use of two different yeasts as starter cultures (non-disclosed strains of *Saccharomyces cerevisiae*, previously isolated at the fermentation site) on the resulting volatile composition of raw and roasted cocoa beans.

## Methods and Materials

### Fermentation

*Tritinario* Beans  
Dominican Republic

Spontaneous **Box-1**  
Yeast-1 Inoculum **Box-2**  
Yeast-2 Inoculum **Box-3**

### Natural Sun Drying

600kg  
April 2020  
4, 5 and 6 days

120°C  
25min

### Roasting

Monolayer  
Convection Oven  
Whole-Bean-Roasting

SPME-HS  
50/30-µm DVB/CAR/PDMS

### Volatile Analysis

Capillary Column DBWAX  
60 m × 0.25 mm  
x 0.25 µm film thickness

Internal Standard:  
Butanol-1

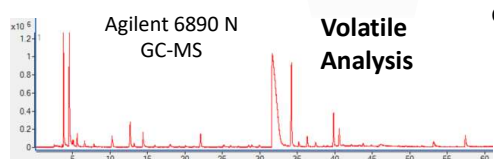


Figure 1. Protocol for fermentation, sample processing and analysis.

## Conclusions

- Differences in volatile composition associated to the fermentation technique are most important after four days of fermentation.
- Yeast inoculum highest potential: at least five days of fermentation.
- Cocoa products derived using these starter cultures could exhibit a more intense flavor profile and may express different fruity profiles.

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## References

- [1] Ziegler, G. (2009). Flavour Development in Cocoa and Chocolate. In *Industrial Chocolate Manufacture and Use*: Fourth Edition. <https://doi.org/10.1002/978144301588.ch8>
- [2] Rodríguez-Campos, J., Escalona-Buendía, H. B., Contreras-Ramos, S. M., Orozco-Avila, I., Jaramillo-Flores, E., & Lugo-Cervantes, E. (2012). Effect of fermentation time and drying temperature on volatile compounds in cocoa. *Food Chemistry*, 132(1), 277–288. <https://doi.org/10.1016/j.foodchem.2011.10.078>

## Results and Discussion

### Raw Beans

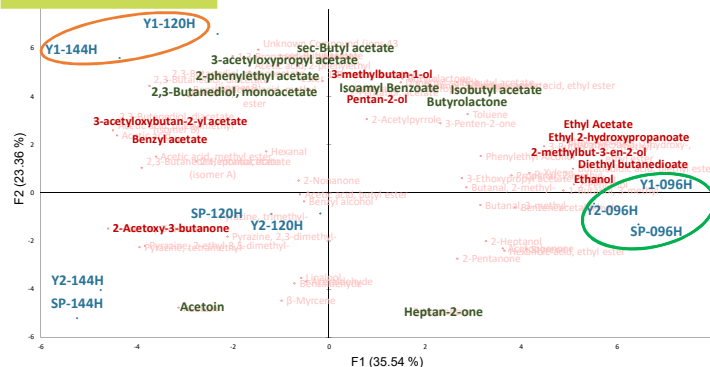


Figure 2. Biplot (axes F1 and F2: 58.90 %) of PCA performed on the 58 volatile compounds found in the raw bean samples. In red: ten main compounds linked to F1 axis and to samples fermented for 96h. In green: compounds most linked to the F2 axis and to samples issued from Yeast-1 inoculum fermentation (fermented for over 4 days).

- Clear differentiation of samples driven by fermentation duration. Compounds linked to shortest fermentations indicate that cocoa products resulting therefrom could exhibit the following sensory characteristics:

**Mostly present:** alcoholic, green, winey, pungent-fruity notes.

**Mostly absent:** sweet, fruity, floral notes.

- At least nine compounds differentiate beans fermented with Yeast-1 inoculum from others. These compounds could indicate that products derived from Yeast-1 inoculum fermented beans could potentially exhibit mostly a fruity, banana-like flavor, with hints of floral and honey notes.

### Roasted Beans

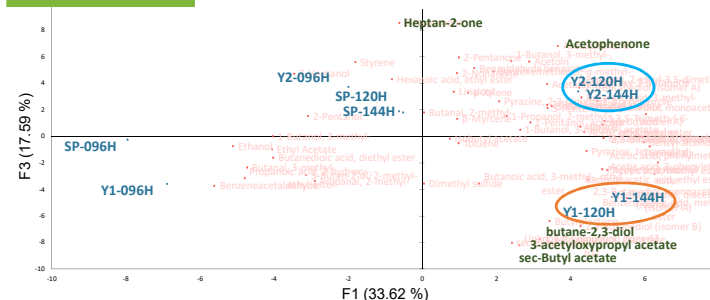


Figure 3. Biplot (axes F1 and F3: 51.20 %) of PCA performed on the 65 volatile compounds found in the roasted cocoa bean samples. In green: compounds most linked to the F3 axis and which point to have some differentiating power between samples issued from both, Yeast-1 and Yeast-2 inoculum fermentations.

- Differentiation power of fermentation time is partially lost after roasting.
- Discrimination per fermentation technique is more evident after roasting, especially when starter cultures are used.

- At least five compounds were found to partly describe differences in volatile composition between samples fermented using the two different yeasts. Flavors linked to these compounds could point to unique fruity notes present in final products obtained from cocoa beans derived from each:

**Yeast 1:** creamy, buttery, and banana-like notes.

**Yeast 2:** sweet, almond-like and fruity notes.

- Higher aromatic potential in samples fermented for longer and for which a yeast starter culture was used, compared to spontaneous fermentation.