**Influence of cocoa origin and roasting parameters on the physico-chemical properties of cocoa beans and liquor**

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The main objective of this PhD project is to evaluate the influence of cocoa bean origin (variety and production area) and roasting parameters (temperature, time, air flow) on the physico-chemical and sensory profiles of cocoa beans and liquor in order to find production markers useful for correlation with beans and the quality of liquor.

**Influenza della origine del cacao e dei parametri di tostatura sulle proprietà fisico-chimiche di fave e paste di cacao**

Lo scopo di questo progetto di dottorato è quello di valutare l’effetto dell’origine delle fave di cacao (varietà e area di produzione) e dei parametri di tostatura (temperatura, tempo e flusso dell’aria) sul profilo fisico-chimico e sensoriale delle fave di cacao e della pasta al fine di individuare dei marker correlabili con la qualità finale di questi prodotti.

# 1. State-of-the-Art

Physico-chemical and sensory characteristics of chocolate depend on a large number of production phases such as the origins of cocoa beans, post-harvest practices, including fermentation and drying, roasting process that transforms the molecules known as aroma precursor, which are generated during fermentation by proteolysis of the proteins stored inside this bean (Janek *et al.,* 2016), milling, tempering and so on. During roasting, flavour precursors generated during fermentation interact to produce the desired chocolate flavour (Ramli *et al.,* 2008) then an efficient roasting phase is essential for the optimal production of aromatic volatile compounds in the final product.

Roasting can also affect several cocoa bean properties such as rheological, physico-chemical and sensory ones and afterwards selecting the most suitable roasting parameters is fundamental for the quality of the chocolate but also of cocoa liquor (Swiechowski, 1996). The knowledge of the relationship between cocoa beans’ origin, roasting parameters, physico-chemical and sensory profiles of cocoa beans and cocoa liquor are crucial in order to maximize the quality of final products. Several studies have shown in fact that temperature and roasting time significantly influence the rheological, chemical, sensory and nutritional characteristics of chocolate (Farah *et al.,* 2012) but also the characteristics of cocoa liquor can be influenced by the same production parameters. For example, it is possible to preserve the polyphenolic profile and obtain a liquor and a chocolate with a high nutritional value selecting appropriate roasting parameters (Zyzelewicz *et al.,* 2018).

Subsequently, the main objective of this PhD project is to evaluate the influence of cocoa bean origin (variety and production area) and roasting parameters (temperature, time, air flow) on the physico-chemical and sensory profiles of cocoa beans and liquor in order to find production markers useful for correlation with beans and liquor quality.

# 2. PhD Thesis Objectives and Milestones

In particular, this research work will be organized into following activities:

A1) Cocoa beans of different varieties (Forastero, Trinitario, Criollo) from different production area will be obtained from local manufacturers. Before roasting, rheological, physicochemical parameters as moisture, water activity, pH, total acidity, color (L\* a\* b\* values), total antioxidant capacity by ABTS, DPPH and FRAP assays, total phenolic content (TPC), volatile compounds, sugars and acidic profile will be assessed.

A2) After this characterization the cocoa beans will be roasted by applying different process parameters. In particular, the cocoa beans will be roasted at four different temperatures (from 110 °C to 150 °C), four different time (from 15 to 45 min.) and two different air velocity (from 1 to 0.5 m/s). A Central Composite Design will be used in order to evaluate the effect of each parameter and their combinations.

A3) Rheological behavior of unroasted and roasted samples obtained by applying different process parameters will be studied by means of rheological empirical-imitative analysis (using a Texture Analyser) to find rheological marker related to origin and roasting parameters. Additionally, polyphenol and fatty acid profile, antioxidant capacity (DPPH and ABTS), volatile components (by using gas-chromatography coupled to a mass spectrometry) will be evaluated on cocoa beans, to find also correlation with their origin and roasting parameters.

A4) Production of cocoa liquor using cocoa beans of different origins and undergone to different roasting treatments. Cocoa liquor will be obtained at laboratory level by using pilot equipment.

A5) Rheological, physico-chemical and sensory characterization of these cocoa liquors will be performed in order to find markers related to cocoa origin and roasting process.

A6) Writing and editing of the PhD thesis, scientific papers and oral and/or poster communications.

***Table 1*** Gantt diagram for this PhD thesis project.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Activity/ Months** | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** |
| A1) | ***Physico-chemical characterization of unroasted cocoa beans*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A2) | ***Roasting processes of cocoa beans according to a CCD using different roasting parameters*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A3) | ***Physico-chemical characterization of roasted cocoa beans*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A4) | ***Production of cocoa liquor using pilot plant*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A5) | ***Rheological, physico-chemical and sensory characterization of cocoa liquor*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A6) | ***Data analysis, manuscripts and thesis preparation*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

# 3. Selected References

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