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Influence of Pre-roasting and Re-roasting on the Physicochemical Properties and Sensory Quality of Arabica Coffee Beans

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Introduction

- Coffee roasting involves temperature–time control causing key physicochemical changes.
- Color and roast degree determined by melanoidin formation via Maillard and caramelization reactions.
- Roasting leads to moisture loss, compound degradation, and formation of new volatile aroma compounds.
- Chlorogenic acids (4–12%) degrade to quinic and caffeic acids, affecting acidity, bitterness, and quality.
- This study examined how pre-roasting and re-roasting affect the physicochemical and sensory qualities of coffee.

Materials/Methods

- **Coffee samples:** Kenyan Arabica (SAZA Coffee Ltd., Japan).
- **Roasting:** ROST L100 smart roaster.
- **Moisture:** by oven-drying (105°C) until constant weight.
- **Weight loss:** measured before/after roasting.
- **Density:** Free-settled method as displacement liquid.
- **Color**: Measured by color meter (NR-11) in L*, a*, b* scale
- **Volatile compounds**: GC–MS (Shimadzu QP2010 Plus) , MonoTrap headspace.
- **Chlorogenic acid**: HPLC Shimadzu LC-20A, C18 VP-ODS.
- **Morphology** : Scanning electron microscopy (Hitachi TM4000Plus).
- **Sensory analysis**: SCA cupping protocol.

Results/Discussion

- **Moisture & Density**: Moisture dropped from 9.25% → 5.25%; density from 1.1 → 0.61 g/mL.
- **Aroma Compounds** (GC–MS): 27 volatiles identified; furfural, pyrazines, and furanmethanol increased up to 6–7 min. Re-roasting enhanced nutty and bready notes; excessive roasting reduced volatiles.
- **Chlorogenic Acids** (HPLC):Declined from 35 → 14 mg/g (pre-roast) and 13.3 → 6.6 mg/g (re-roast).
- **Sensory Analysis**: Re-roasted 3–6 min samples scored highest for aroma, flavor, aftertaste, acidity, and body.5-min re-roast showed best overall balance.
- **Morphology** (SEM): Pores expanded from 21 → 41 µm by end of roasting.

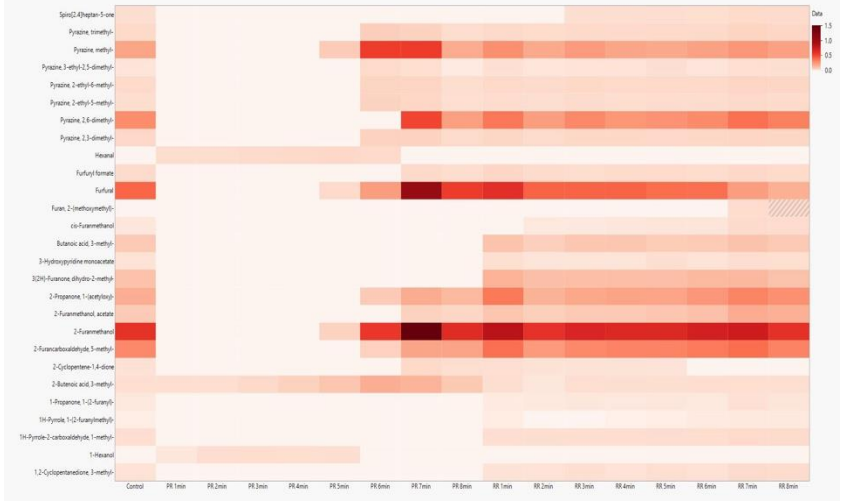

Figure 1. Heat map of GC–MS data showing the distribution of aroma compounds during pre-roasting and re-roasting of coffee beans.

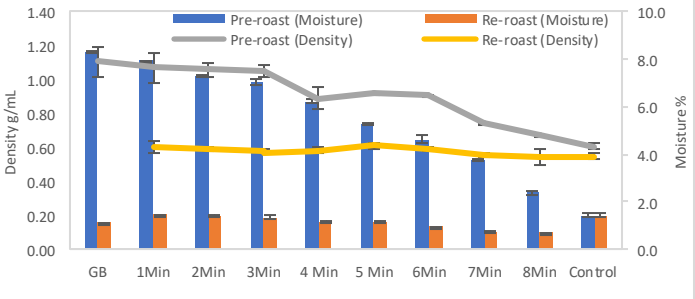

Figure 2. Moisture and density changes in coffee beans during pre-roasting and re-roasting.

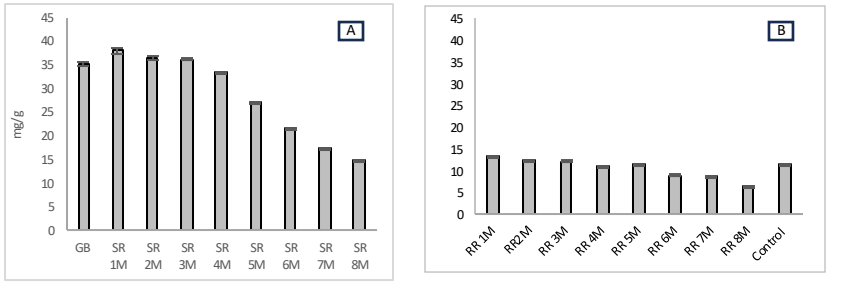

Figure 3. (a) Chlorogenic acid content during pre-roasting and (b) changes in chlorogenic acid during re-roasting

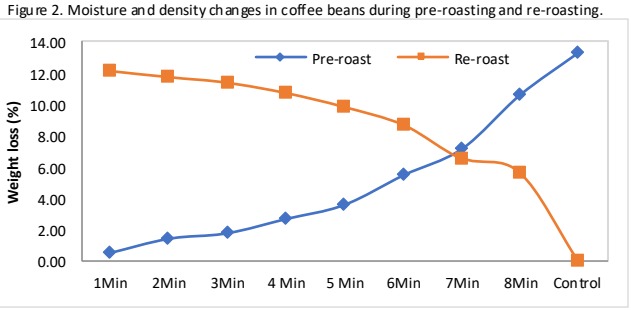

Figure 4. Weight loss of coffee beans during pre-roasting and re-roasting.

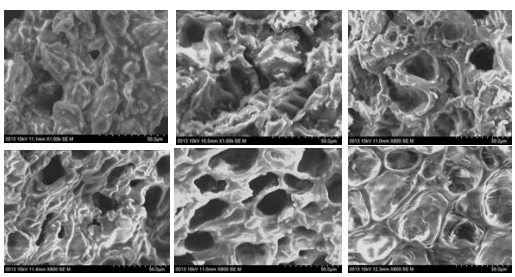

Figure 5. SEM images of coffee beans at different roasting stages.

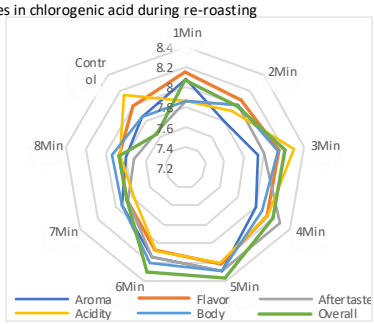

Figure 6. Sensory data of major sensory attributes in re-roasted coffee samples.

Conclusion/Perspectives

Controlled pre-roasting and re-roasting significantly affected coffee's moisture, density, color, and internal structure, indicating key physicochemical transformations.

Aroma compounds peaked around 5 min of pre and the re-roasting and chlorogenic acids declined progressively, leading to improved flavor balance and sensory quality in re-roasted coffee.