Dissertation Title	Coffee Characteristics Evaluation from Cherries to Roasted Beans: A Case of Northern Thai Arabica Coffee
Author	Sai Aung Moon
Degree	Doctor of Philosophy (Food Science and Technology
Advisor	Assistant Professor Rattapon Saengrayap, D. Eng.
Co-Advisor	Sirirung Wongsakul, Ph. D. Associate Professor Hiroaki Kitazawa, Ph. D.

ABSTRACT

Thai coffee is celebrated globally for its distinct flavors and aromas, yet farmers encounter numerous obstacles, including unstable prices, limited market access, high production costs, and issues in farm and postharvest management. Key challenges include climate change, mix varieties growing, contamination from fungi and mycotoxins, insufficient facilities for drying, storage, and packaging, and variable weather impacting drying processes, which leading to inconsistent quality. Postharvest drying is critical for reducing microbial growth and developing desired flavors, while storage conditions significantly affect green coffee bean (GCB) quality. Extended storage, typically six months to a year, often leads to oxidation, resulting in quality loss through browning, aroma degradation, off-flavors, and increased spoilage risk. This research studies the impact of various drying, processing, and storage techniques on Thai coffee quality.

In dying techniques on their physicochemical characterizes, this research examines the effects of different drying methods and post-harvest processing techniques on the quality of Thai GCB and roasted coffee beans (RCB). Thai coffee producers utilize sun drying (SD), controlled-environment drying (CED) at 20–30 °C and 50–55% RH, and fast drying (FD) at 30–45 °C to enhance quality and cupping scores. Results show that drying and processing methods significantly impact the

physicochemical properties of GCB, including true density, moisture content, water activity, color, caffeine, trigonelline, chlorogenic acid, caffeic acid, sucrose, and fructose. CED produced the highest levels of these qualities, followed by SD and FD. The study also highlights that roasting decreases initial GCB qualities while developing characteristic flavors and aromas. Among post-harvest processes, dry processing (DP) yielded the highest caffeine, trigonelline, and chlorogenic acid levels, while honey processing (HP) increased sucrose and fructose, enhancing flavor complexity in the cup.

In accelerated storage and packaging, this study investigated lipid oxidation in GCB under accelerated storage conditions (30, 40, and 50°C with 50% RH) and various packaging types: plastic woven (PW), low-density polyethylene (LDPE), and hermetic (GrainPro®/GP) bags. Samples collected every five days over 20 days were analyzed for oxidation markers, including acid value (AV), free fatty acids (FFA), peroxide value (PV), ρ-anisidine value (PAV), total oxidation value (TOTOX), and thiobarbituric acid reactive substances (TBARS), as well as moisture content, water activity, and color. Results showed primary and secondary oxidation with increasing AV, FFA, PAV, PV, and TBARS, impacting flavor and aroma. Higher temperatures accelerated lipid oxidation and quality degradation, with GP bags best preserving GCB quality by minimizing oxidation rates. The study highlights that selecting appropriate storage conditions and packaging materials, particularly hermetic packaging, is essential to maintaining GCB quality during storage.

In accelerated storage and non-destructive techniques, this study evaluated the shelf-life and lipid oxidation of DP and HP coffees stored in GP bags under accelerated storage at 30, 40, and 50 °C with 50% RH. Using a kinetic model, the shelf-life was estimated at 45.67, 29.9, and 24.92 days for DP, and 60.34, 38.07, and 19.22 days for HP at 30 °C, 40 °C, and 50 °C, respectively. Partial least squares (PLS) modeling demonstrated predictive accuracy for TBARS (R^2 = 0.801) and peroxide values (PV) (R^2 = 0.469) with significant wavenumber ranges identified via ATR-FTIR spectroscopy as indicators of lipid oxidation. ATR-FTIR proved effective for non-destructive, rapid analysis of oxidation, and demonstrated that lower storage

temperatures extended GCB shelf-life. Findings confirm that temperature and processing method significantly influence GCB shelf-life, with ATR-FTIR as a valuable tool for quality monitoring during storage.

In roasting profiles, this study examines the effects of roasting levels and storage conditions on coffee quality by evaluating moisture content, color, peroxide value, shelf-life, and volatile compounds using SPME-GCMS. Coffee samples from Doi Chang, Thailand, processed by DP, WP, and HP were roasted to light (205°C), light-medium (210°C), and medium (218°C) levels, then stored in hermetic bags under accelerated conditions (30, 40, and 50°C, 50% RH) for up to 21 days. Roasting level and storage temperature significantly influenced (p<0.05) coffee quality, with higher temperatures accelerating degradation. Eighty-two volatile compounds were identified, with furans (35.20–53.55% d.w.), pyrazines (13.16–32.31% d.w.), and esters (4.21–16.70% d.w.) being the dominant contributors to aroma. Shelf-life at 30°C was longest for light roast (10.03–11.68 days), followed by light-medium (7.28–8.82 days) and medium (6.33–7.68 days). Washed coffee exhibited better long-term stability than honey and natural-processed coffee. While volatile compound concentrations generally declined during storage, organic acids, phenolics, and pyrazines increased due to thermal oxidation, with the most significant changes occurring at 50°C. These findings provide valuable insights for coffee roasters and buyers in optimizing storage conditions to preserve coffee quality and extend shelf-life.

In dying techniques on their volatile compound and cupping, this study explores the effects of drying techniques; CED, SD, and FD combined with processing methods; DP, WP, and HP on the quality of roasted Thai coffee. CED-DP and CED-HP achieved the highest cupping scores of 83.17 ± 1.26 and 83.33 ± 0.58 points, respectively, with CED enhancing ester and nitrogenous compounds, SD increasing acids, alcohols, and ketones, and FD promoting acetate compounds. PCA revealed an 87.97% correlation between volatile compounds and cupping scores. DP was linked to high acidity, sweetness, and ester content; WP to uniformity and clean cup; and HP to sensory qualities like body and balance. CED proved most effective for enhancing acidity and flavor complexity, while FD showed higher pH and lower acidity, with each method

contributing unique volatile profiles. Key volatile compounds were identified for each process, supporting the potential for tailored drying and processing methods to improve flavor and aroma in specialty coffee. This study offers insights for Thai producers and positions establishment for further research on optimizing coffee quality across different climatic conditions.

Therefore, this research outlines a comprehensive strategy for improving specialty coffee quality through advancements in drying, storage, packaging, roasting, and analysis. Controlled environment drying (CED) dramatically enhanced physicochemical and sensory properties, particularly in dry and honey-processed beans. Accelerated shelf-life testing, along with enhanced lipid oxidation markers and ATR-FTIR spectroscopy, revealed new, non-destructive insights into coffee stability. Optimizing the roasting profile had a further impact on volatile component retention and shelf life. Concurrently, these advances contribute to a comprehensive approach for increasing flavor, uniformity, and storage stability, benefiting farmers, roasters, and quality systems in Thailand and abroad.

Keywords: Accelerated Storage, Drying, Multivariate Analysis, Non-destructive, Specialty Coffee