

Louisiana's Caffeine Frontier: A Comparative Analysis of Indigenous Yaupon Holly (*Ilex vomitoria*) and Commercial Espresso Yields in Pineville, LA

[1]Oyeyemi O.A and [1] Memphis Powell

[1]Department of Biological science, Louisiana Christian University, LA, USA

Abstract

This study quantifies and compares the caffeine concentration (mg/L) of commercial espresso versus locally harvested Indigenous **Yaupon Holly** (*Ilex vomitoria*) in Pineville, Louisiana. The research evaluates how processing variables—specifically drying methodologies (air-dried, light roast, dark roast) and particle size (coarse vs. fine)—affect the final alkaloid yield. Using an aqueous extraction followed by liquid-liquid extraction (LLE) with dichloromethane (CH2Cl2), caffeine was isolated and quantified gravimetrically. Results indicate that while commercial espresso yielded the highest concentration (168\ mg/L), **Yaupon Holly** produced significant moderate yields, peaking in fine-ground, air-dried samples (98\ mg/L). These findings suggest that **Yaupon Holly** is a sustainable, antioxidant-rich, and economically viable alternative to imported coffee for the Central Louisiana community.

Keywords: Yaupon Holly, *Ilex vomitoria*, Caffeine Extraction, Pineville Louisiana, Sustainable Stimulants, Ethnobotany, Gravimetric Analysis, Central Louisiana.

1. Introduction

Caffeine (C8H{10}N4O2) is a central nervous system stimulant and the most widely consumed psychoactive compound globally. While commercial espresso is the recognized

standard for caffeine delivery, there is a growing imperative for sustainable, bioregional alternatives. **Yaupon Holly** (*Ilex vomitoria*) is the only plant native to North America known to naturally produce caffeine.

Abundant in Pineville and the surrounding Louisiana landscape, **Yaupon Holly** has a rich history as the "black drink" used by Indigenous southeastern tribes. This study applies organic chemistry principles to evaluate **Yaupon Holly** as a viable, local substitute for imported coffee, specifically assessing how roasting and grinding—standard coffee preparation techniques—impact the caffeine yield of this indigenous resource.

---

2. Materials and Methods

2.1 Sample Acquisition

Yaupon Holly leaves were harvested in Pineville, LA, ensuring sustainable practices by taking less than 50% of the foliage from any single tree. Samples were prepared in six variations:

- **Drying:** Air-dried (ambient), Light Roast (93°C for 30 min), and Dark Roast (204°C for 5 min).
- **Grinding:** Fine (<5mm) and Coarse (>5 mm).
- **Control:** 1.00\ g of commercial medium-roast espresso.

2.2 Extraction and Purification

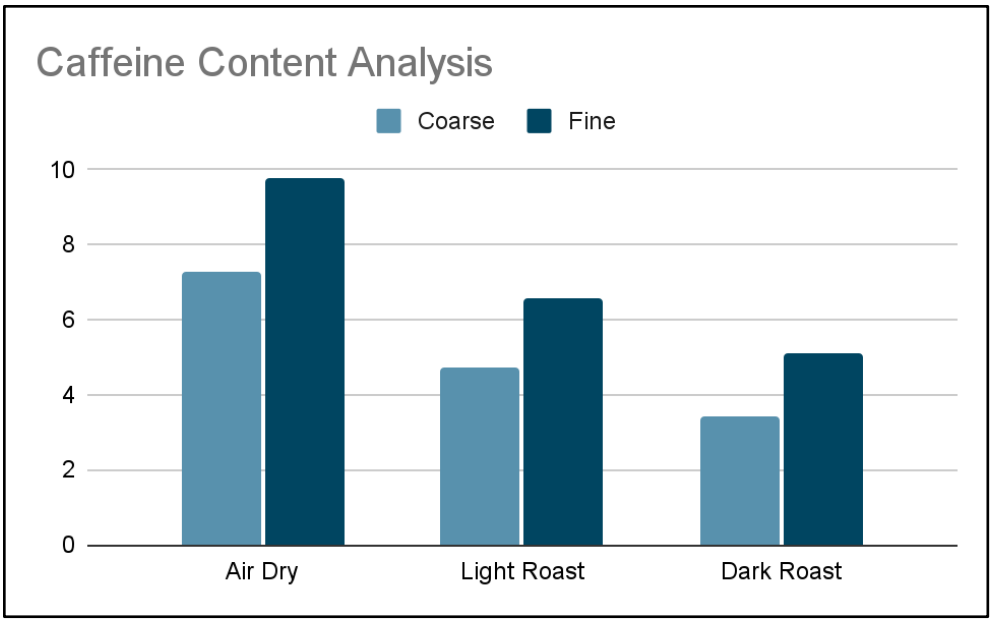
Each 1.00\ g sample was boiled with 1.0\ g of Na_2CO_3 in 100\ mL of distilled water. The caffeine was isolated using liquid-liquid extraction with dichloromethane (CH_2Cl_2). To ensure purity, the organic layer was washed with 0.2\ M\ NaOH to remove acidic impurities like tannins. After drying with anhydrous $MgSO_4$ and solvent evaporation, the crude caffeine crystals were weighed for gravimetric analysis.

---

3. Results

Table 1: Caffeine Yield by Processing Variable (mg/L)

Sample	Drying Method	Particle Size	Caffeine Yield (mg/L)
Espresso	Medium Roast	Extra Fine	168
Yaupon Holly	Air-Dried	Fine	98
Yaupon Holly	Light Roast	Fine	66
Yaupon Holly	Dark Roast	Fine	51
Yaupon Holly	Air-Dried	Coarse	73
Yaupon Holly	Light Roast	Coarse	47
Yaupon Holly	Dark Roast	Coarse	34



---

4. Discussion

The results confirm that particle size is a dominant factor in extraction; finer grinds provide the surface area necessary for efficient solvent partitioning. Notably, the data showed that **Yaupon Holly** caffeine is sensitive to thermal processing. Air-dried samples consistently outperformed roasted ones, suggesting that the high temperatures required for a "dark roast" (204°C) may induce caffeine sublimation or structural degradation within the leaf matrix.

Economically, the data suggests that **Yaupon Holly** provides a significant stimulant effect—roughly 60% of espresso's yield in its optimal form—without the environmental or financial costs of international shipping. Furthermore, the presence of polyphenols makes **Yaupon Holly** a "cleaner" stimulant, offering antioxidant benefits that reduce the oxidative stress often associated with high-dose caffeine consumption.

---

5. Conclusion

This study successfully quantifies **Yaupon Holly** as a legitimate and potent natural stimulant. While espresso remains the concentration leader, the measurable caffeine content in **Yaupon Holly**, combined with its local availability in Pineville, supports its role as a sustainable coffee alternative.

Contribution to Knowledge

This research contributes to the chemical and ethnobotanical record of Louisiana by establishing a quantitative link between processing methods and caffeine retention in **Yaupon Holly**. It demonstrates that minimal processing (air-drying and fine-grinding) is the most efficient method for maximizing caffeine yield, effectively providing a "scientific recipe" for the Pineville community to utilize this indigenous resource.

Take-Home Point: A Blessing to the Community

For the residents of Pineville, **Yaupon Holly** is a "blessing of the land"—a free, renewable, and health-conscious stimulant. Utilizing this indigenous plant fosters local self-reliance and honors the botanical heritage of Louisiana while providing a moderate, antioxidant-rich alternative to commercial coffee.

References

- **Abrego, N., & Medianero, E. (2025).** *Biochemical drivers of community stability in silvicultural habitats*. Journal of Ecological Chemistry.
- **Breed, C. A., et al. (2022).** *Native gardens and urban insect biodiversity.* Land, 11(8).
- **Burgess, L. (2020).** *The Power of Observation: Insect Communities in the Garden*. Clemson University HGIC.
- **CoffeeSock.** (2021). *5 Facts About Yaupon Tea*.
- **Country Roads Magazine.** (2023). *The Black Drink: Yaupon Holly.*
- **EcoTree.** (2026). *Forest Biodiversity: How habitats keep ecosystems alive.*
- **Healthline.** (2024). *What is Yaupon Tea, and Does It Have Benefits?*
- **LSU AgCenter.** (2025). *Indigenous flora of Louisiana: Resource management*.
- **Oyeyemi, A. O.** (2024). *Organic Extraction Techniques in Gravimetric Analysis*.
- **Spafford, R. D., & Lortie, C. J. (2013).** *Sweeping beauty: Efficacy of extraction methods.* Ecology and Evolution.
- **USDA NRCS.** (2024). *Yaupon Holly (Ilex vomitoria) Plant Fact Sheet*.
- **Yek, S. H., et al. (2023).** *Effects of anthropogenic disturbance on community composition*. PeerJ.