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Department of Nutrition and Food Sciences

A Qualitative and Quantitative Flavor Profile Comparison between Premium vs. Low-Quality Coffee Brews

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Abstract

People appreciate coffee for its enjoyable sensory quality, including aroma, taste, and mouthfeel. This study aimed to compare the flavor profile between a premium and low-quality coffee brew. Approximately 150 aroma volatiles were identified using SPME-GC-MS, and the premium quality coffee brew consisted of a higher concentration of volatiles. Premium quality coffee also had a higher °Brix & Total Dissolved Solids (1.2% & 1.02%) than low quality (0.8% & 0.68%), whereas TA was observed to be higher for low quality (0.28g/L) than premium (0.17g/L). In contrast, HPLC-UV resulted in a significantly higher nucleotide content (umami taste) such as IMP, GMP, AMP, and CMP in low-quality coffee except for 5'UMP. Mouthfeel-related compounds such as total protein were higher in premium, while total lipids and total polyphenols were higher in the low-quality brew. This study contributes significantly to understanding coffee's flavor (aroma, mouthfeel, acidity, flavors, or aftertaste).

Objectives

The objectives of this project were to establish the quality markers of premium and low-quality coffee based on the flavor differences including aroma, taste, and texture through qualitative instrumental and quantitative analysis by investigating:

- aroma-related volatiles from top notes through SPME-GCMS/O;
- taste-related non-volatiles for sweetness through °Brix; sourness through titrable acidity and organic acids using HPLC; and bitterness through nucleotides quantification using HPLC & astringency through total polyphenols;
- mouthfeel sensations through total lipids and total protein determination.

Background & Motivation

The aroma, taste, and mouthfeel attributes of coffee are found to be the primary key factors that influence the quality traits of coffee, making it desirable or undesirable. Coffee is among the most researched beverage based on the great preference for consumption, however, there are only a few studies indicating its quality difference based on the flavor components. The findings will be crucial in marketing and pricing based on the quality and preference attached to a particular type of production process, chemical composition, or flavor attributes.

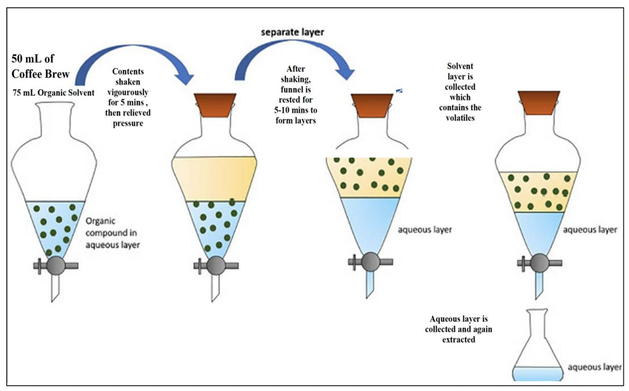
Experimental

Sample Preparation :

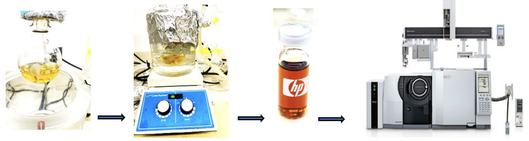
Aroma Volatiles:

1g Salt + 4 g Coffee Brew

Injected into SPME-GCMS; extracted organic compounds for 20 mins at 80°C incubation from headspace concentrates and desorb into GC for 3 min with injection temp of 230°C



Dichloromethane (DCM) is used for LLE for Volatile analysis



Vigreux Distillation is done till the solvent is concentrated by evaporating al DCM till 2 mL

Concentrate is then filtered into vials and injected into GCMS-O. The volatiles are identified and sniffed for characteristic aroma.

Taste Non-Volatile:

Titrando > Refractometer Titratable acidity > °Brix (Sourness & Sweetness)	Spectrophotometer > Total Polyphenols (Astringency & Bitterness)	HPLC > Nucleotides (Bitterness) Organic acids (sourness)
> Brewed coffee is filtered into a 50 mL beaker > Titrando is standardized with strong buffer solution NaOH > Concentration of total soluble solids is measured with degree of refraction > pH – measure of acidity; standardized with pH 4,7,10 → inserting bulb in the coffee brew, recorded	>1mL of coffee brew was added to 9mL acetone >200 uL Folin-Ciocalteu incubated + 1 mL Na_2CO_3 > Incubated 15 min at 50°C > 200 uL plated --> read at 750 nm → TPC content expressed as g GAE/100g	>5% methanol and 95% water (5:95, v/v), 0.05% phosphoric acid → 80 µL sample – flow rate 1 mL/min → UV detection 259 nm > KH_2PO_4 buffer with phosphoric acid & methanol (95:5, v/v) → 80 µL sample – flow rate 1 mL/min → UV detection 214 nm

Mouthfeel: (Total Lipid & Total Protein)

Petroleum Ether is used with LLE for Total Lipid analysis

Separation of lipid layer and aqueous layer

Extract is collected in round bottom flask and then petroleum ether is evaporated on hot burner under hood and remaining residue is the evaporated with rotary evaporator

Dried flask is then weighed to calculate the weight of lipids

Total Protein analysis

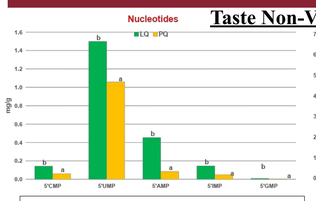
Coffee brew is weighed, dried and powdered before Kjeldahl Protein analysis

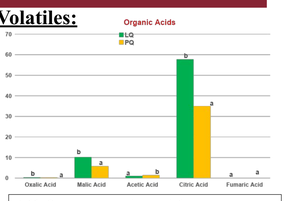
0.5g of coffee brew powder is weighed in weighing paper and added to Kjeldahl flask with Kjeldahl tablets and digested for 3 hours

Digested sample is then titrated with 0.1 N NaoH which is then analyzed for N-content & total protein

Results & Discussion

Taste Non-Volatiles:



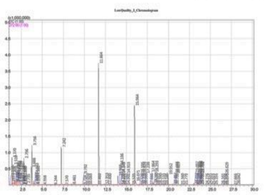


All four nucleotides except 5'GMP showed significant difference ($\alpha < 0.002$) for t-test

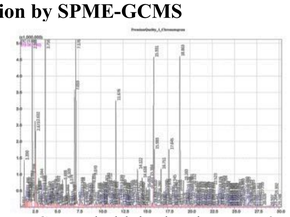
All four organic acids except fumaric acid showed significant difference ($\alpha < 0.005$) for t-test

pH and Total Polyphenols showed significant differences ($\alpha < 0.001$) between low & premium quality coffee both being higher for low quality. No significant difference was observed for TA & °Brix.

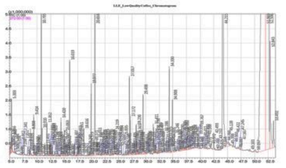
Aroma Volatiles: Identification by SPME-GCMS

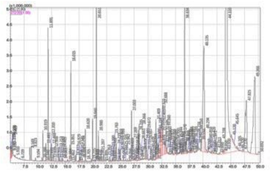


- Several fatty acids identified
- Propanoic, hexanoic, butanoic acids
- Odor & flavor characteristics of waxy, buttery, cheesy, sharp, sour, nutty & earthy
- Green compounds were also identified



- Several aldehydes, ketones & alcohols identified
- Furans, Furfurals & Pyrazine compounds majorly identified
- Odor & flavor characteristics of chocolate, cocoa, caramel, fruity, nutty, sweet burnt almonds, & coffee

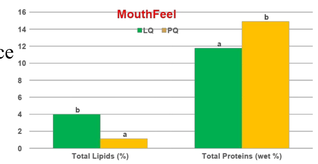




- Similar compounds were identified for both samples
- Odor & flavor characteristics are the same as the SPME – identified volatiles

Mouthfeel:

t-test for Equality of Means proves a significant difference of $\alpha < 0.001$ for both total lipids (F value = 0.446) & total proteins (F value = 2.179)



Conclusion

- The Taste Non–Volatiles data indicates significant relation between bitterness & nucleotides as well as sourness & organic acids, both contributing to the characteristic strong odor & flavor of low-quality coffee.
- pH & Total Polyphenols were found to be higher in low-quality coffee.
- The Aroma Volatiles quantification & identification correlated with both SPME-GCMS & LLE-GCMS methods. Striking similarities were observed in the compounds and their odor & flavor characteristics. Low-quality coffee brews had more fatty compounds with waxy, fatty & green notes, whereas premium quality was seen to have desirable aldehydes, alcohols, and pyrazine compounds giving its desirable chocolate, fruity, caramelly & cocoa notes.
- The Mouthfeel attributes are significantly related to the higher lipid for low quality & higher protein content for premium quality explaining the related taste & flavor profiles.

References

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