Abstract #50

Descriptive aroma and flavor volatiles of four commercial coffees prepared using four brew methods

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Introduction

- The World Coffee Research Sensory Lexicon describes a dynamic list of flavor and aroma attributes in a variety of coffees (World Coffee Research 2016).
- The aroma attributes are influenced by a variety of factors, of concern here are degree of roast and brew method.

Objective

To determine whether degree of roast or brew method can influence volatile aroma compositions in brewed coffee, related to aroma in the coffee lexicon.

Methods and Materials

- **Coffees** Folgers® Breakfast Blend, Folgers® Classic Roast, Folgers® 100% Columbian, Folgers® Black Silk
- **Preparation Methods** Cold Brew, Drip, French Press, Pour Over
- **Collection Temperatures** 70ºC
- **Expert, trained flavor descriptive attribute panel** evaluated using the Spectrum® Universal 16-point scale (0 = none and 15 = extremely intense
- **Volatiles** using the Agilent Technologies GC-MS with an olfactory port and AromaTrax System; 2 panelists evaluated volatile, aromatic compounds for presence
- **Analysis** Volatiles were measured as total ion count areas under the curve of each peak and analyzed using analysis of variance with coffee and brew method and their interaction as fixed effects



Results

Table 1. Least squares means for GC volatile compounds for four commercial coffee blends

Code[f]	Volatile Compounds	P Value[e]	Commercial Coffee Blends			
			Breakfast[d]	Classic[d]	Colombia[d]	Black[d]
C2	1H-Pyrrole	0.008	116375^{bc}	176932^{ab}	82578^{c}	212025^{a}
C7	1H-Pyrrole, 1-methyl	0.03	529542^{a}	678047^{a}	202333^{b}	502286^{ab}
C8	2-(2-Propenyl)-furan	0.001	99993^{c}	154298^{b}	214844^{a}	165443^{ab}
C10	2-Furancarboxaldehyde	0.0002	2062766^{b}	2390310^{b}	3840727^{a}	2008049^{b}
C17	2,3-Pentanedione	0.001	9644^{b}	270280^{a}	90104^{b}	142600^{b}
C24	Benzeneethanol, 2-methoxy	0.04	137144^{ab}	144641^{ab}	89621^{b}	203514^{a}
C28	Dicyclobuylidene oxide	0.03	7471^{b}	24540^{ab}	15560^{ab}	32376^{a}
C33	Furan, 2-(2-furanylmethyl)	0.009	100650^{b}	151844^{ab}	208287^{a}	159277^{ab}
C38	Furan, 2,2'-methylenebis-	0.02	381732^{b}	552619^{ab}	56514^{ab}	691140^{a}
C45	Phenol, 2-methoxy-	0.04	206770^{a}	209041^{ab}	142039^{b}	293071^{a}
C49	Pyrazine, 3-ethyl-2,5-dimethyl	0.02	149473^{a}	146778^{a}	59123^{b}	133464^{a}
C51	Pyridine	0.001	963511^{bc}	1140365^{ab}	577740^{c}	1561872^{a}
C52	Pyrimidine, 4,6-dimethyl	0.04	1.45e-11^{b}	141893^{ab}	1.45e-11^{b}	273332^{a}
C58	1-Formylcyclopentene	0.006	3742^{a}	6782^{b}	23210^{a}	3398^{b}
C63	2-cyclopenten-1-one, 3-ethyl-2-hydroxy	0.007	1762^{b}	0^{b}	36849^{a}	8691^{b}
C65	2-Furancarbonitrile	0.002	1232^{b}	1110^{b}	0^{b}	4940^{a}
C66	2-Furancarboxaldehyde, 5-methyl	0.01	1465282^{b}	1333111^{b}	2373411^{a}	10711504^{b}
C75	2,3-Dihydro-6-methylthieno[2,3c]furan	0.02	145369^{b}	311943^{a}	201691^{b}	193790^{b}
C76	2,3-Hexanedione	0.005	7.276e-12^{c}	5286^{bc}	41130^{a}	24252^{ab}
C95	Furan, 2-[(methyldithio)methyl]	<0.0001	41820^{b}	55466^{ab}	15252^{c}	77003
C97	Hexanal	0.02	67076^{a}	62458^{a}	8833^{b}	27467^{ab}
C106	Pyrazine, ethyl	0.002	361603^{a}	430418^{a}	173836^{b}	181340^{b}
C111	1H-Pyrrole-2-carboxaldehyde, 1-ethyl	0.01	17881^{ab}	25616^{a}	1.819e-12^{c}	9991^{bc}
C112	1H-Pyrrole, 2,5-dimethyl	0.02	19243^{ab}	21851^{ab}	6470^{b}	31979^{a}
C119	2-2'-Bifuran	0.0002	41529^{b}	33437^{b}	94196^{a}	35989^{b}
C126	Benzene, 4-ethenyl-1, 2-dimethoxy	0.003	2106^{b}	5371^{b}	15839^{a}	5697^{b}
C129	Bicyclo[3.3.1]nonane	0.03	9.095e-13^{b}	0^{b}	3586^{a}	25796^{a}
C136	Oxepine, 2,7-dimethyl-	0.03	27004^{b}	78501^{a}	48718^{ab}	59625^{ab}
C140	Pyrazine, 2,5-dimethyl-	0.0002	233572^{a}	514396^{a}	123935^{b}	91296^{a}
C145	Pyrimidine	0.04	39984^{ab}	94393^{a}	8695^{a}	35767^{ab}
C146	Thiopene, 3-methyl	0.03	9146^{b}	29871^{a}	10962^{b}	9539^{b}
C155	Acetic Acid	0.01	7.276e-12^{b}	4055^{b}	67891^{a}	1106^{b}
C163	Pyrazine, 2-etheyl-5-methyl	0.04	6986^{a}	1421^{b}	4.548e-13^{b}	1738^{b}
C173	1,3-Butadiene, 2-methyl	0.01	1292^{b}	1086^{b}	9142^{a}	1627^{b}
C183	3-Buten-2-one, 4-(2-furanyl)	0.001	505^{b}	668^{b}	5953^{a}	1328^{b}
C194	Pyridine, 2-methyl	0.02	520^{b}	-1.8193e-12^{b}	-1.819e12^{b}	11110^{a}
C204	2-Cyclopenten-1-one, 3-methoxy-5-methyl-	0.01	4.548e-13^{b}	0^{b}	7444^{a}	2867^{ab}
C207	6,7-dihydro-5-methyl-cyclopentapyrazine	0.04	4428^{a}	602^{b}	-2.274e-13^{b}	482^{b}
C247	2-Butenal	0.03	2862^{ab}	429^{b}	5930^{a}	0^{b}
C249	2,5-Dimethyl-3-ethylfuran	0.001	684^{b}	11071^{a}	444^{b}	9.095e-13^{b}
C266	Ethanone, 1-(2-hydroxyphenyl)	0.006	7.958e-13^{b}	397^{b}	3347^{a}	9.095e-13^{b}
C269	2-Butanoyl furan	0.02	9.095e-13^{b}	9.095e-13^{b}	7887^{a}	6.821e-13^{b}
C270	4,6-Dimethylpyridine-2(1H)-one	0.003	9.095e-13^{b}	-1.819e-12^{b}	18815	-1.819e-12
C271	1,3-Heptodiene, 2,3-dimethyl	0.01	-1.819e-12^{b}	-1.819e-12^{b}	16375^{a}	-4.547e-13^{b}

[abc] Mean values within a column and effect followed y the same letter are not significant different(*P*>0.05).
[d] Breakfast = Folgers® Breakfast Blend, Classic = Folgers® Classic Roast, Colombia= Folgers® 100% Colombia, Black= Folgers® Black Silk
[e] P value from Analysis of Variance table
[f] Code found on Figure 1 Partial Least Squares Regression Biplot

Table 2. Least squares means for GC volatile compounds for four brew method

Code[f]	Volatile Compounds	P Value[e]	Brew Method[d]			
			Cold[d]	Drip[d]	French[d]	Pour[d]
C5	1H-Pyrrole, 1-(2-furanylmethyl)-	0.001	378704^{b}	598817^{a}	571179^{b}	345661^{b}
C8	2-)2-Propenyl)-furan	0.001	121056^{b}	132098^{b}	221734^{a}	159690^{b}
C13	2-Methoxy-4-vinylphenol	0.04	197718^{b}	353039^{a}	294477^{ab}	179716^{b}
C25	Benzoic acid, 2-hydroxy-, methyl ester	0.04	50273^{b}	110666^{a}	78527^{ab}	59074^{b}
C33	Furan, 2-(2-furanylmethyl)-5-methyl	0.01	103456^{b}	199979^{a}	171029^{a}	145563^{ab}
C38	Furan, 2,2;-methylenebis	0.0005	297212^{c}	619534^{ab}	742700^{a}	531185^{b}
C41	Furan, 3-phenyl	0.002	14794^{c}	53474^{a}	50577^{ab}	30236^{bc}
C43	N-Methyl-2,5-dimethylpyrrole	0.04	5012^{a}	997^{b}	3773^{ab}	1234^{b}
C52	Pyrimidine, 4,6-dimethyl	0.02	94931^{ab}	0^{b}	250554^{a}	69741^{b}
C61	1,3-Pentadiene	0.003	3954^{a}	282^{b}	-2.274e-13^{b}	591^{b}
C72	2-Pyridinamine, 5-methyl	0.01	178200^{a}	61276^{b}	37050^{b}	0^{b}
C75	2,3-Dihydro-6-methylthieno[2,3c]furan	0.01	113953^{b}	245974^{a}	298973^{a}	193892^{ab}
C76	2,3-Hexanedione	0.02	39217^{a}	10803^{b}	3935^{b}	16714^{ab}
C86	Benzeneacetaldehyde, alpha. -Ethylidene	0.02	6504^{c}	17078^{a}	14966^{ab}	8728^{bc}
C94	Ethanone, 1-(2-thienyl)	0.03	23019^{ab}	31135^{a}	22323^{ab}	9589^{b}
C95	Furan, 2-[(methyldithio)methyl]	<0.0001	15002^{c}	68321^{a}	67717^{a}	38500^{b}
C107	Trisulfide, dimethyl	0.004	42353^{b}	76225^{b}	166016^{a}	99233^{b}
C109	1-(5-Methylfurfuryl)-pyrrole	0.01	4546^{b}	26003^{a}	11325^{b}	7737^{b}
C110	1-Furfuryl-2-formyl pyrrole	0.01	1919^{c}	17689^{a}	14757^{ab}	5959^{bc}
C111	1H-Pyrrole-2-carboxaldehyde, 1-ethyl	0.03	11752^{ab}	10710^{b}	4274^{b}	26751^{a}
C115	2-Methyl-3(2-furyl)acrolein	0.01	3991^{b}	17878^{a}	10115^{ab}	10042^{ab}
C118	2-Vinyl-5-methylfuran	0.005	133389^{b}	302946^{b}	224986^{a}	271299^{b}
C119	2-2'-Bifuran	0.02	27639^{b}	51129^{ab}	55369^{a}	71013^{a}
C121	3-Heptanone, 5-methyl	0.001	16732^{a}	1520^{b}	0^{b}	1.819e-12^{b}
C133	Furan, 2-pentyl	0.0004	2252^{c}	21092^{b}	41481^{a}	8640^{bc}
C136	Oxepine, 2,7-dimethyl	0.0005	29621^{b}	4177^{b}	101845^{a}	40756^{b}
C148	1H-Indole-5-carboxaldehyde, 2,3-dihydro-1-methyl	0.02	0^{b}	3639^{a}	3822^{a}	2024e-13^{b}
C151	2H-1-benzopyran	0.03	787^{b}	13149^{a}	0^{b}	3667^{ab}
C163	Pyrazine, 2-ethenyl-5-methyl	0.04	-9.095e-13^{b}	4116^{ab}	6030^{a}	0^{b}
C174	1H-Indole, 1-methyl	0.03	9.095e-13^{b}	3638^{ab}	9747^{a}	1772^{b}
C177	2-(Carboxymethylthio)-pyrimidine	0.01	-2.274e-13^{b}	4358^{a}	131^{b}	-2.274e-13
C178	2-Acetyl-3-ethylthiophene	0.01	-9.095e-13^{b}	15478^{a}	-1.819e12^{b}	12949^{a}
C184	Benzofuran, 2-ethenyl	0.03	1758^{b}	17446^{ab}	21064^{a}	1576^{b}
C204	2-Cyclopenten-1-one, 3-methoxy-5-methyl	0.03	4.548e-13^{b}	4.548e-13^{b}	4670^{ab}	5641^{a}
C224	Nona-3,5-dien-2-one	0.02	5743^{a}	6.821e-13^{b}	2.274e-13^{b}	1475^{b}
C226	4-phenylbut-3-ynylamine	0.003	6772^{a}	4.548e-13^{b}	0^{b}	1849^{b}
C247	2-Butenal	0.01	4.548e-13^{b}	6869^{a}	1046^{b}	1126^{b}

[abc] Mean values within a column and effect followed y the same letter are not significant different(*P*>0.05).
[d] Cold=Cold Brew, Pour= Pour-over, French= French Press
[e] P value from Analysis of Variance Table
[f] Code found on Figure 1 Partial Least Squares Regression Biplot

Table 3. Least squares means for GC volatile compounds of Brew Method and Coffee Type Interaction

Treatment	1H-Pyrrole, 1-ethyl (C6)	Dicyclo-butylidene (C28)	1,2-Pentadiene (C59)	2-Cyclopenten-1-one, 3-ethyl-2-hydroxy (C63)	2,3-Hexanedione (C76)	Furan, 2-pentyl (C133)	Oxepine, 2,7-dimethyl (C136)	1-(5-Methyl-2-furanyl)-1-propen-3-al (C166)	2-Acetyl-3-ethylthiophene (C178)	3-Thiophene carboxaldehyde (C206)	2-Pyridinamine, 3-methyl (C222)	-Heptan (C233)	3,6-iso Benzofuroquinone (C268)
P value[f]	0.01	0.003	0.03	0.04	0.01	0.009	0.0004	0.007	0.03	0.004	0.03	0.03	0.01
Breakfast*Cold[g]	0^{b}	12178^{b}	-1.137e-13^{c}	7048^{bc}	-1.455e-11	9.095e-13^{d}	11364^{de}	3.412e-13^{b}	1.819e-12^{c}	9.095e-13^{b}	-7.276e-12^{b}	23805^{a}	2.842e-14^{b}
Breakfast*Drip[g]	0^{b}	8131^{bc}	6.253e-13^{c}	1.819e-12^{c}	-1.819e-12^{c}	1130^{d}	14725^{de}	5438^{b}	12248^{bc}	0^{b}	0^{b}	8200^{bc}	1.421e-14^{b}
Breakfast*French[g]	-3.638e-12^{b}	3.638e-12^{c}	0^{c}	-1.819e-12^{c}	-7.276e-12^{c}	27609^{bcd}	61821^{cde}	0^{b}	4.5475e-13^{c}	5.457e-12^{b}	3.638e-12^{b}	0^{c}	1.421e-14^{b}
Breakfast*Pour[g]	-3.638e-12^{b}	9576^{bc}	0^{c}	-1.819e-12^{c}	-5.457e-12^{c}	12786^{d}	20107^{cde}	9.095e-13^{b}	4.093e-12^{c}	-1.819e-12^{b}	0^{b}	-1.819e-12^{c}	2.842e-14^{b}
Classic*Cold[g]	0^{b}	10910^{bc}	4.548e-13^{c}	9.095e-13^{c}	-1.091e-11^{c}	-1.819e-12^{d}	46614^{cde}	-2.274e-13^{b}	-1.819e12^{c}	4.548e-12^{b}	169143^{a}	-9.095e-12^{c}	0^{b}
Classic*Drip[g]	-3.638e-12^{b}	31386^{bc}	-9.095e-13^{c}	-3.638e-12^{c}	-1.046e-11^{c}	1969^{d}	68124^{cd}	0^{b}	7.276e-12^{c}	10978^{b}	-1.819e-12^{b}	9.095e-13^{c}	1.421e-14^{b}
Classic*French[g]	5.457e-12^{b}	34862^{b}	-4.547e-13^{c}	5.457e-12^{c}	-9.095e-12^{c}	57805^{ab}	137951^{ab}	-1.819e-12^{b}	-4.093e-12^{c}	-7.276e-12^{b}	0^{b}	13082^{ab}	412^{b}
Classic*Pour[g]	-1.819e-12^{b}	21002^{bc}	8995^{a}	-3.638e-12^{c}	21145^{bc}	21772^{cd}	59516^{cde}	4172^{b}	38442^{a}	17076^{b}	-9.095e-12^{b}	0^{c}	0^{b}
Colombia*Cold[g]	0^{b}	3.183e-12^{c}	2.274e-13^{c}	7.731e-12^{b}	100194^{a}	2.729e-12^{d}	40168^{cde}	9.095e-13^{b}	-1.819e-12^{c}	-3.638e-12^{b}	-1.455e-11^{b}	9.095e-13^{c}	986^{a}
Colombia*Drip[g]	3.638e-12^{b}	35620^{b}	5326^{ab}	87544^{a}	2876^{c}	52450^{abc}	64358^{cde}	1819e-12^{b}	15382^{abc}	0^{b}	-2.365e-11^{b}	4.548e-13^{c}	-5.684e-14^{b}
Colombia*French[g]	-1.819e-12^{b}	6.253e-12^{c}	0^{c}	10639^{bc}	15741^{bc}	8364^{d}	6948^{de}	17685^{a}	-2.274e-12^{c}	1.455e-11^{b}	-3.638e-12^{b}	-1.819e-12^{c}	0^{b}
Colombia*Pour[g]	-1.819e-12^{b}	26623^{bc}	-9.095e-13^{c}	49213^{ab}	45710^{bc}	-3.638e-12^{d}	83399^{bc}	-9.095e-13^{b}	13353^{bc}	0^{b}	3.820e-11^{b}	3.638e-12^{c}	-1.137e-13^{b}
Black*Cold[g]	200953^{a}	15793^{bc}	1580^{bc}	34764^{bc}	56671^{ab}	9007^{d}	20338^{cde}	7.958e-13^{b}	-6.821e-13^{c}	-1.819e-12^{b}	1.455e-11^{b}	0^{c}	0^{b}
Black*Drip[g]	0^{b}	-1.091e-11^{c}	1.251e-12^{c}	3.638e-12^{c}	40337^{bc}	27609^{bcd}	17499^{cde}	8379^{b}	34281^{ab}	0^{b}	2.910e-11^{b}	7.958e-13^{c}	0^{b}
Black*French[g]	0^{b}	84592^{a}	9.095e-13^{c}	1.364e-12^{c}	1.273e-11^{c}	72145^{d}	200663^{d}	9.095e-13^{b}	0^{c}	86401^{a}	1.455e-11^{b}	-6.253e-13^{c}	-1.421e-14^{b}
Black*Pour[g]	0^{b}	29121^{bc}	5.684e-13^{c}	4.093e-12^{c}	1.091e-11^{c}	0^{d}	1.455e-11^{e}	1.819e-12^{b}	-9.095e-13^{c}	0^{b}	258821^{a}	1.478e-12^{c}	1.421e-14^{b}

[abcde] Mean values within a column and effect followed y the same letter are not significant different(*P*>0.05).
[f] Breakfast = Folgers® Breakfast Blend, Classic = Folgers® Classic Roast, Colombia= Folgers® 100% Colombia, Black= Folgers® Black Silk, Cold=Cold Brew, Pour= Pour-over, French= French Press
[g] P value from Analysis of Variance table

Correlations on axes t1 and t2

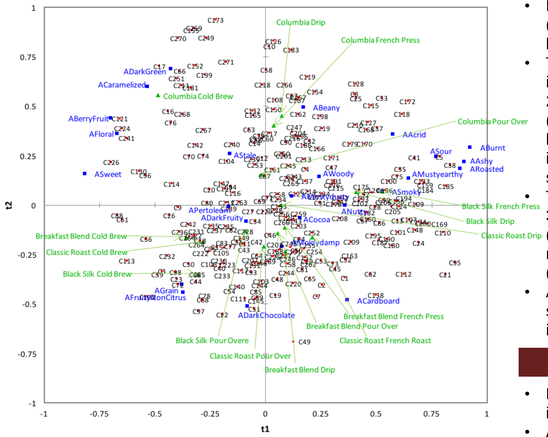

Figure 1. Partial least squares regression biplot for descriptive sensory aroma attributes (■), volatile compounds (●) and coffee samples (▲).

- 44 volatile compounds and 36 volatile compounds out of 271 differed across coffee types/degree of roast and brew method, respectively.
- Pyridine Pyridine (C51), 5-methyl-furancarbaldehyde (C66) and 2-methoxyphenol (C45) were influenced by roasting level.
- The 100% Columbian coffee was highest (P < 0.05) in 2,5-dimethyl-3-ethylfuran (earthy, roasted aroma), 2,3-hexanedione (buttery), 2,5-dimethyl pyrazine (earthy, roasted), and acetic acid (vinegar), and was lowest (P < 0.05) in hexanal (green aroma, an indicator of oxidation), and 5-methyl furfural (sweet, spicy, caramel aroma).
- The drip brew method was the highest (P < 0.05) in 3-ethyl phenol (medicinal), 2,3-dimethyl pyrazine (nutty, cocoa), 2-ethyl-5-methyl pyrazine (nutty, roasted), and dimethyl trisulfide (onion), and lowest (P < 0.05) in 2,5-dimethyl furan (spicy, smoky).
- Among the 271 volatile compounds, only 13 of them showed significant difference when testing the interaction of coffee types and brew methods.

Conclusion

- Brew Method and Degree of end roast significantly impacted volatile aroma compounds.
- Aromatic volatiles can be correlated to aromas found on the World Coffee Research Sensory Lexicon

References

World Coffee Research Sensory Lexicon, 2016