

SUPPLEMENTARY MATERIAL

Variability of volatile compound profiles during two coffee fermentation times in northern Peru using SPME-GC/MS

Table S1. List of volatile compounds identified in fermented coffee beans during long (L) and short (S) fermentation processes. The values are the mean of three replications. Data are expressed as the relative areas in percentage. Asterisks by the chemical compounds indicate that they were significantly different among fermentation times at (*) $p < 0.05$, (**) $p < 0.01$, and (***) $p < 0.001$.

Chemical Group	Compound	Relative areas (%)							
		L				S			
		6h	12h	18h	22h	27h	32h	5h	9h
Acids	n-Decanoic acid	0.479	0.688	0.341	0.281	0.096	0.105	0.279	0.734
	Dodecanoic acid	0.295	0.306	0.188	0.035	0.030	0	0.081	0.146
	Nonanoic acid	0.221	0.380	0	0.092	0.053	0.044	0	0
Alcohol	Phenylethyl Alcohol **	4.285	6.401	3.258	8.427	5.418	13.102	11.323	5.627
	3-Octanol	0.676	0.662	0	0	0	0	1.212	2.215
	1-Butanol, 2-methyl-	0.630	1.099	0.995	1.531	1.743	1.965	1.325	0.582
	1-Hexanol, 2-ethyl-	0.245	0.190	1.768	0	0	0.118	0	0
	2-Heptanol **	10.239	9.867	9.861	2.149	1.218	1.529	7.451	9.769
	1-Hexanol	0.057	0.062	0.290	0.134	0.148	0	0.646	0
	3-Octen-2-ol, (Z)-	0.677	0.000	0	0	0.325	0	0	0
	2-Hexanol	0.077	0	0	0	0	0	0	0
	3-Octen-2-ol, (E)-	0	1.637	0	0	0.282	0.210	0	0
	1-Butanol, 3-methyl-	0	0.839	1.550	3.837	4.524	5.379	3.035	0
	1-Butanol, 3-methyl-, acetate ***	9.698	7.601	7.486	19.433	19.807	6.014	0.666	1.817
	1-Pentanol, 4-methyl-	0	0	0	0	0	0.107	0	0
	1-Octen-3-ol	0	0	0	0	0	0	1.877	4.624
Aldehydes	Benzaldehyde ***	7.706	6.939	5.910	3.339	8.544	6.186	21.279	0

Aromatic hydrocarbons	Toluene	0.917	0.907	0.943	0.457	0.576	1.022	0.087	2.500
	Styrene **	9.641	5.988	5.605	1.694	2.071	2.954	3.090	5.468
Benzenes	Ethylbenzene ***	1.142	0.564	0.276	0.128	0.085	0.123	0.284	0.566
	Benzene, propyl-	0.763	0.405	0.388	0.036	0	0	0.189	0.320
	Benzene, 1,4-dimethoxy-	0.553	0.737	0.555	0.294	0.267	0.234	0	0
	Benzene, 1,4-diethyl-	0	0	0	0	0.037	0.134	0	0
	Benzene, 1,3-diethyl-	0	0	0	0	0	0.050	0	0
Esters	Benzoic acid, 2-hydroxy-, ethyl ester	0.066	0.113	0.109	0.036	0.022	0.018	0.011	0.096
	Acetic acid, 2-ethylhexyl ester	0.324	0	0.355	0	0	0	0	0
	Acetic acid, 2-phenylethyl ester	2.226	5.337	4.426	5.141	0	0	0	0
	Benzeneacetic acid, ethyl ester *	3.662	3.267	7.709	4.679	8.048	8.551	0*	2.454
	Acetic acid, hexyl ester	0.149	0.356	0.354	1.483	1.369	2.115	0	0
	Acetic acid, butyl ester	0.116	0.050	0.237	0.027	0.047	0.217	0	0
	Butanoic acid, 2-methyl-, ethyl ester	0.148	0.171	0.385	0.096	0.096	0.175	0.121	0.211
	Hexanoic acid, methyl ester	0.077	0.041	0.104	0	0	0	0.235	0.414
	Propanoic acid, butyl ester	1.199	1.283	1.776	0	0.008	0.030	0	1.860
	Butanoic acid, 3-methyl-, ethyl ester	1.803	1.827	3.657	2.795	3.130	3.874	0.783	2.813
	Benzeneacetic acid, methyl ester	0	0.214	0	0	0.097	0	0	0.372
	Acetic acid, octyl ester	0	0.768	0.634	2.905	2.432	3.905	0	0
	Butanoic acid, butyl ester	0	0	0.358	0	0	0	0	0
	Hexanoic acid, ethyl ester	0	0	0.636	1.341	1.436	1.799	0	0
	Octanoic acid, ethyl ester	0	0	0.049	0.898	1.567	3.505	0	0
	Benzoic acid, ethyl ester	0	0	0	0.041	0.166	0.731	0	0
	Isobutyl acetate	0.865	0.370	0.197	0.605	0.484	0.437	0	0.135
	Dodecanoic acid, ethyl ester	0	0	0	0.143	0.257	0.860	0	0
	Tetradecanoic acid, ethyl ester	0	0	0	0	0.045	0.140	0	0
	Decanoic acid, ethyl ester	0	0	0	0	0	1.348	0	0
Acetic acid, nonyl ester	0	0	0	0	0	0.317	0	0	

	Pentanoic acid, 3-methyl-, ethyl ester	0	0	0	0	0	0.084	0	0
	Acetic acid, heptyl ester	0	0	0	0	0	0.311	0	0
	Butanoic acid, ethyl ester	0	0	0	0	0	0.053	0	0
Ethers	n-Butyl ether	0.595	1.028	0	0.017	0	0.071	0	0.808
Furans	Furan, 2,3-dihydro-4-methyl-	0.286	0.704	0.888	0	0.106	0.075	0	0
	Furan, 2-pentyl-	0.992	1.465	1.914	0.961	0.703	1.054	0	0.593
Ketones	3-Pentanone	0.779	0.630	0	0.082	0	0	0.081	1.239
	2-Pentanone	0.328	0	0.308	0	0	0	0	0.122
	3-Octanone	0.354	0.374	0.276	0	0	0	0.681	0.820
	5-Hepten-2-one, 6-methyl-	0.652	0.626	0.540	0.158	0.121	0.187	0.702	1.004
	2-Heptanone ***	1.618	1.500	1.660	0.177	0.052	0.087	1.270	1.846
	Acetophenone	0.768	0.574	0.407	0	0	0.511	0	0
	Acetoin	0.753	1.163	2.697	0.887	0.977	1.557	0.027	2.612
	2-Nonanone	0	0.078	0	0	0	0	0	0
	2-Acetoxy-3-butanone	0	0	2.514	0	0	0	0	0
	2-Octanone	0	0	0	0	0	0	0.054	0
Pirazines	Pyrazine, 2-methoxy-3-(2-methylpropyl)- **	1.634	2.213	1.756	0.546	0.679	0.616	2.673	5.570
	Pyrazine, 2-methoxy-3-(1-methylpropyl)-	0	0	0	0	0	0	0	0.094
Terpenes	o-Cymene **	2.205	0.874	0.987	0.133	0	0.055	0.359	0.834
	1,3,6-Octatriene, 3,7-dimethyl-, (Z)-	0.076	0	0	0	0	0	0	0
	3-Carene	0.072	0.069	0.071	0	0	0	0	0
	.gamma.-Terpinene	0.622	0	0.081	0.088	0	0	0	0
	p-Cymene	0	0.271	0.358	0	0	0	0	0
	Azulene, 1,2,3,3a,4,5,6,7-octahydro-1,4-dimethyl-7-(1-methylethenyl)-, [1R-(1.alpha., 3a.beta.,4.alpha.,7.beta.)]-	0	0	0.246	0	0	0.258	0	0
	.beta.-Guaiene	0	0	0	0.160	0.496	0	0	0
	Valerena-4,7(11)-diene	0	0	0	0.195	0	0	0	0
	Benzene, 1-methyl-3-(1-methylethyl)-	0	0	0	0	0	0	0.157	0.200

Others

Cyclohexene, 6-ethenyl-6-methyl-1-(1-methylethyl)-3-(1-methylethylidene)-, (S)-	0.149	0	0	0	0	0	0	0
Methyl salicylate	0.961	0.659	1.136	0	0	0.195	1.066	1.438
Naphthalene, 1,2,4a,5,8,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-, (1.alpha., 4a.beta.,8a.alpha.)-(./-.)-	0.335	0.084	0.161	0	0	0	0	0.100
Benzene, (1-methylethyl)-	0.265	0.121	0.139	0	0	0	0.078	0.131
Benzene, 1,3-dimethyl-	1.269	0.999	1.227	0.199	0.171	0.251	0.325	0.838
Benzene, 1-methoxy-3-methyl-	0.793	0.552	0.626	0.220	0.195	0.355	0.424	0.403
Benzene, 1,3-dichloro-	0.186	0.060	0.074	0	0	0	0	0
Undecane, 2-methyl-	0.278	0.246	0.280	0.302	0.158	0	0.912	1.403
Anisole	0.727	0.084	0.065	0	0.045	0	0.166	0.246
cis-2-(2-Pentenyl) furan	0.198	0.128	0.172	0.091	0	0	0.112	0.340
Benzene, 1,2-dimethoxy-	0.765	0.756	0.580	0	0	0	0	0
1-Butanol, 2-methyl-, acetate *	0.964	1.000	1.077	10.020	3.506	0	0	0.251
2-Pentanol, acetate	0.098	0.043	0.127	0	0	0	0	0
2,4-Dimethyldodecane	0.408	0	0.113	1.093	0.624	0	2.491	1.965
Benzene, 1,2,4-trimethyl-	0.474	0	0	0	0	0	0	0
Cyclohexane, pentyl-	0.206	0	0.069	0	0	0	0	0
Heptane, 2,2,4,6,6-pentamethyl-	0.358	0	0	0	0	0	0	0
2,6,10-Trimethyltridecane	0.038	0	0	0.405	0.928	0.540	0.438	0.546
Benzene, 1,4-dichloro-	0.126	0.156	0.093	0	0	0	0	0
Benzene, 1,2,3-trimethyl-	0.476	0	0.618	0	0	0	0	0
trans-4a-Methyl-decahydronaphthalene	0.096	0	0	0	0	0	0	0
2-Ethyl-oxetane	0	7.703	3.059	0.581	1.541	2.853	6.283	7.310
Bicyclo[3.1.0]hex-2-ene, 2-methyl-5-(1-methylethyl)-	0	0.043	0.027	0	0	0	0.011	0.027
Nonane, 4,5-dimethyl-	0	0.481	0	0.196	0.188	0	0.275	0
Undecane, 2,6-dimethyl-	0	0.346	0.115	0	0.065	0.174	0	1.644
Undecane, 3-methyl-	0	0.026	0	0	0	0	0	0

Others

2-Butanol, 3-methyl-, acetate	0	0.023	0	0	0	0	0	0
5-Ethylcyclopent-1-enecarboxaldehyde	0	0.362	0	1.355	1.144	1.370	0	2.204
3-Ethyl-4-methylpentan-1-ol	0	0.155	0	0	0	0.311	0	0
Benzene, 1,2,4,5-tetramethyl-	0	0.027	0	0	0	0	0.023	0.033
Nonane, 5-methyl-5-propyl-	0	0.044	0	0	0	0	0	0
Undecane, 2,7-dimethyl-	0	0.035	0.042	0.146	0.086	0	0.590	0.940
4-Heptanone, 3-methyl-	0	0	0.100	0	0	0	0	0
Undecane, 2,8-dimethyl-	0	0	0.052	0	0	0	0	0
1-Isopropylcyclohex-1-ene	0	0	0	0.087	0.024	0.059	0	0
Benzene, 1,3-dimethoxy-	0	0	0	0.138	0.093	0.120	0.155	0.335
Ammonium acetate	0	0	0	3.401	0.973	0	0	0
Undecane, 2,4-dimethyl-	0	0	0	0.168	0.108	0	0.602	0.979
Nonane, 3-methyl-5-propyl-	0	0	0	0.149	0	0	0.348	0.204
Dodecane, 6-methyl-	0	0	0	0	0.172	0	0.407	0.226
Nonane, 5-(2-methylpropyl)-	0	0	0	0	0.016	0	0	0
1H-Benzocycloheptene, 2,4a,5,6,7,8-hexahydro-3,5,5,9-tetramethyl-, (R)-	0	0	0	0.000	0.133	0	0	0
Benzene, 1-ethyl-2,4-dimethyl-	0	0	0.050	0	0	0	0	0
1,4-Dioxane, 2,5-dimethyl-	0	0	0	0	0	0.021	0	0
3,5-Octadien-2-one, (E,E)-	0	0	0	0	0	0.066	0	0
Cyclohexanecarboxaldehyde	0	0	0	0	0	0.161	0	0
2,4-Heptadienal, (E,E)-	0	0	0	0	0	0.171	0	0
Selina-3,7(11)-diene	0	0	0	0	0	0.066	0	0
1-Decanol, 2-methyl-	0	0	0	0	0	0.061	0	0
Nonane, 2-methyl-5-propyl-	0	0	0	0	0	0	0.134	0.727
Dodecane, 4-methyl-	0	0	0	0	0	0	0.584	0.864
Ethane, 1,1-diethoxy-	0	0	0	0	0	0	0.007	0
Bicyclo[3.1.1]hept-2-ene, 3,6,6-trimethyl-	0	0	0	0	0	0	0.014	0

(1R,9R,E)-4,11,11-Trimethyl-8-methylenebicyclo[7.2.0]undec-4-ene	0	0	0	0	0	0	0	0.309
Cyclohexene,1-propyl-	0	0	0	0	0	0	0	0.047
Cyclohexene, 1-methyl-5-(1-methylethenyl)-, (R)-	0	0	0	0	0	0	0	0.905
5,9-Undecadien-2-one, 6,10-dimethyl-, (E)-	0	0	0	0	0	0	0	0.025

Table S2. Relative abundances (in percentage) of volatile chemical groups identified in fermented coffee beans during the LFP and SFP. The values are the mean of three replications.

Chemical group	LFP				SFP			
	6h	12h	18h	22h	27h	32h	5h	9h
Acids	0.99	1.37	0.53	0.41	0.18	0.15	0.36	0.88
Alcohol	26.58	28.36	25.21	35.51	33.47	28.42	27.54	24.63
Aldehydes	15.34	12.81	12.50	8.48	14.98	12.76	37.04	2.75
Alkanes	12.11	9.27	7.63	10.83	15.82	11.10	8.68	14.34
Aromatic hydrocarbons	10.56	6.89	6.55	2.15	2.65	3.98	3.18	7.97
Benzenes	2.46	1.71	1.22	0.46	0.39	0.54	0.47	0.89
Esters	10.63	13.80	20.99	20.19	19.20	28.47	1.15	8.36
Ethers	0.60	1.03	0.00	0.02	0.00	0.07	0.00	0.81
Furans	1.28	2.17	2.80	0.96	0.81	1.13	0.00	0.59
Ketones	5.25	4.94	8.40	1.30	1.15	2.34	2.81	7.64
Pirazines	1.63	2.21	1.76	0.55	0.68	0.62	2.67	5.66
Terpenes	2.97	1.21	1.74	0.58	0.50	0.31	0.52	1.03
Others	9.17	14.13	10.00	18.55	10.17	6.59	15.44	24.44

Table S3. Relative abundances (in percentage) of volatile chemical groups identified in fermented coffee beans during the LFP and SFP. The values are the mean of three replications.

Volatile Compound	LFP				SFP			
	6h	12h	18h	22h	27h	32h	5h	9h
2-Butenal, 3-methyl-	0.364	0.00	0.00	0.29	0.23	0.14	1.06	1.26
3-Pentanone	0.78	0.63	0.00	0.08	0.00	0.00	0.08	1.24
Furan, 2-pentyl-	0.99	1.47	1.91	0.96	0.70	1.05	0.00	0.59

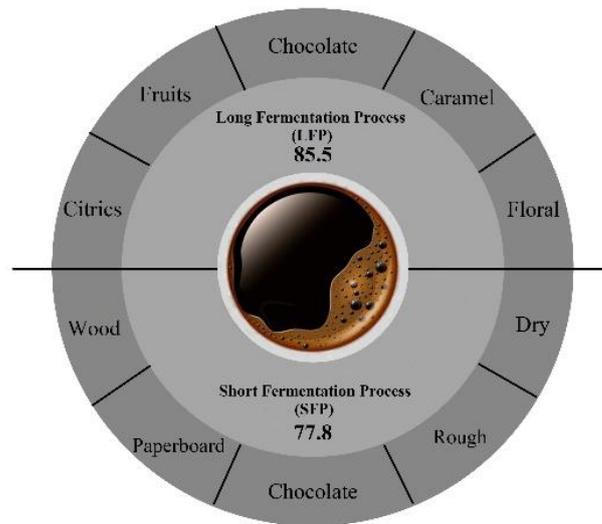


Fig. S1: Flavour attributes and scores of coffee beverages obtained by two fermentation processes (short and long) performed by Q-Graders through cupping.

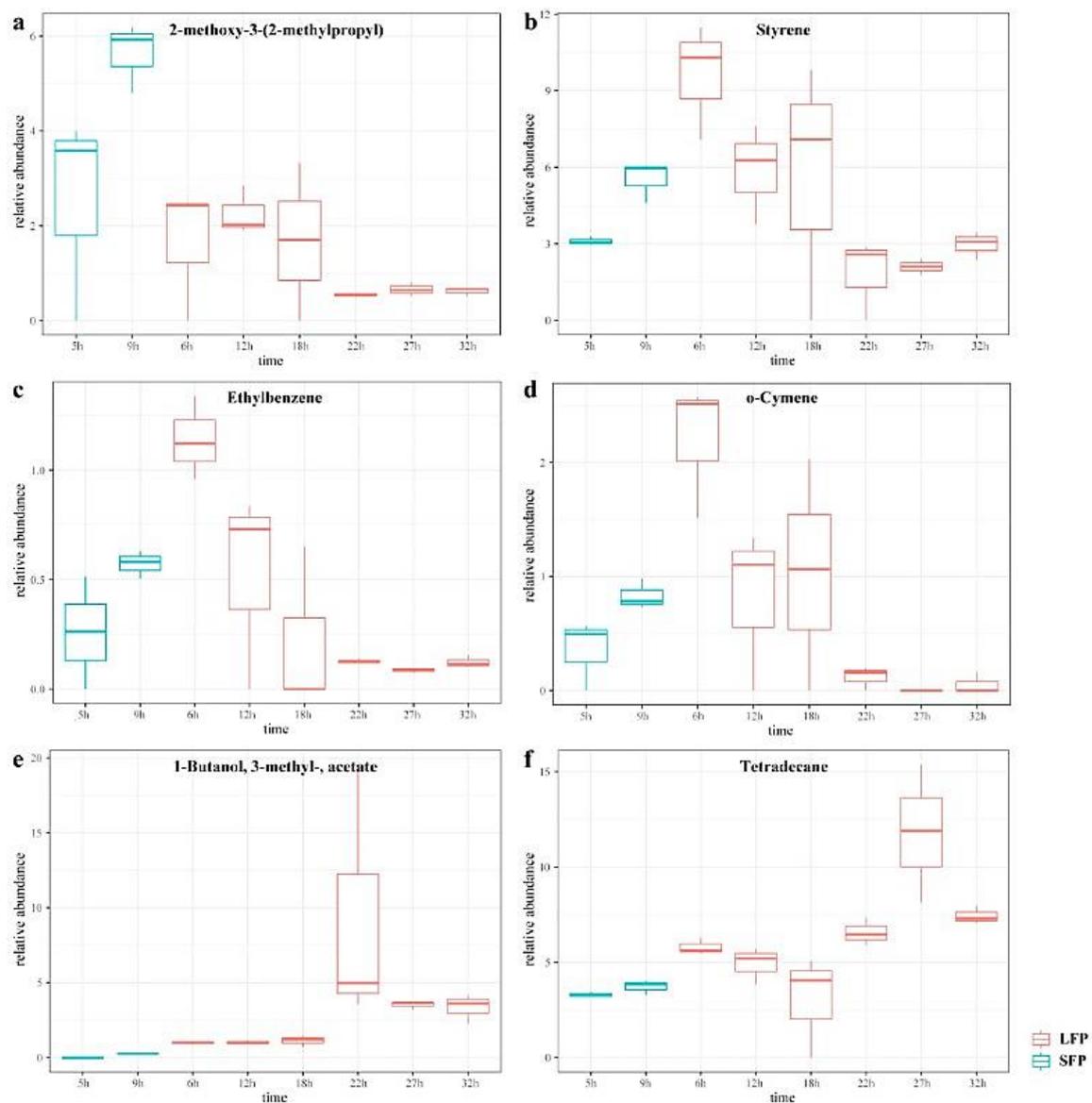


Fig. S2: Relative abundances of the volatile compounds 2-methoxy-3-2-methylpropyl (a), styrene (b), ethylbenzene (c), o-cymene (d), 1-butanol-2-methyl-acetate (e), and tetradecane (f) produced throughout the SFP (5 and 9 h) and LFP (6, 12, 18, 22, 27 and 32 h).

Abstract in Quechua language

Pisi qillqa

Yawiyami Tyimpu kaphi ypuchquypa thatkichay chinchamanta Piruw (isqun pachakuna Tawa chunka esqoniyokkama) llamk'aq kaphiniyuq miraykuna awika allin kasqankuna kaphimanta porqi mana allinchaykayku thatkichay patanchaymi. Hina kaqtintaq, kay ciencia yachay paqtay kikinichay waksiqkuna allichishkakuna kaphi pokoy thatkichaypi kurukunawan (isqun pachakuna) sunikunawan (kinsa chunka iskayniyoq pachakuna) kaphimanta allpa chinchamanta Piruw allichuspay SPME-GC/MS paq masinchay kaphimanta kasqankunawan waksiqkuna allichishkakunawan. Tariqamuran allichishkakunapa Esqon chunka huk llapantin kaphi pokoy thatkichaypi kurukunawan (SFP, inkli simipi); chaykama kikinichakunaraqan pachak tawa chunka hukniyuq allichishkakunapa kaphi pokoy thatkichaypi sunikuna (LFP, inkli simipi). Rikurqun yachasqakuna chakuchakuna piktamantay wayriku achkapi chunka tawayoq allichishkakunapa chaqllikuna kaphi pokoy thatkichaypi kurukunawan sunikunawan ($p < 0.05$). Paykunaq, rikuchi qamuran allichishkakuna (nispan inkli simipi: benzaldehyde, methional, hexanal, 2-heptanone, pentadecane, 1-butanol-3-methyl-acetate, and benzeneacetic acid ethyl ester) ñuqamantaqa sunquyachiy allin kasqankunapi kaphimanta. Kuskina vnanchakuna rikuchi qamuran ima kaphi rikushina kutuwikuna (pichqa pacha, isqun pacha) manta SFP karan manchay ukmankuna, kay siminchay ima waksiqkuna allichishkakuna karan manchay allpariq, chaykama ima kaphi rikushina kutuwikuna manta LFP rikuchirqun pimayqampa huñukuq qutukuy. Kay ciencia yachay rimasqapi ruray takyapakuy anchayupay pokoy pachap mana sapan ima kayninkunawan p'uchukuna allin kasqanwan ukyanamanta, chakumi wawpapi waksiqkuna allichishkakuna puran wallpamakuna thatkichaykuna.

Simi chaniyuq: kaphi, kullay, pokoy pachap, Piruw, SPME-GC/MS, waksiq allichishka, huq'u pokoy

Abstract in Awajun language

Ashi ijugsa tamau

Wajupa tsawag wegakug cafe Perú nujinchi awadusha kajiawa tamak duka kuwashtai (9-48 etsañai) juka juniawai sukutig ematnanunu shit takashmaunum cafeshkam pegken jintsui. Juka augtusmauwai jiman ikajiatai awa nunui ikajia café kugkugtish pegkejash jina nuna dekatasa, sutag (9 etsa) nuwigtu kuashat (32 etsa), juu cafen ajagmatmauwai Perú nujinchin takantsai SPME-GC/MS café kunkutig ashi pachiniakush pegkejashit nunu dekatasa. Ashig ijumjamak 90 dekanai pachimja tsawag sutagnumak ikajiamukmak (SFP); tujashkam 141 dekanai kuashat tsawag ikajiamunmak. Etseggamui kuashat betegchau químico 14 awa duka juka aidawai SFP nuwigtu LFP ($P < 0.05$). juwin, awai benzaldehído, metional, hexanal, 2-heptanona, pentadecano, 1-butanol-3-metil-acetado nuwigtu éster etílico awai ácido bencenoacético tawa nunui juu aidau pegkenchau emawai cafen ameinanuna. Betekashik tusajish digtsai café (5h,9h) estanum SFP numash dutika betegchau dekanai, dutikag tawai kuashtai kugkugti awa duka, tujashkam café tikishnum LPF diyamak wagtigkae pipish tuwamu awa duka. Juu augtusbauwa juka wajupa tsawag ikajiajish pegken umutash jinua nunakeg estegtsui, etsejui jimagnum ikajiamuum kuashat kugkuamu awa nuna.

Chicham etegjamu: Café, chupitig kajiamu, dekapeamu, kugkugti aidau, Perú, SPME-GC/MS, tswag duckapeg kajiamu.