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Short Communication

Caffeine content of Ethiopian *Coffea arabica* beans

Maria Bernadete Silvarolla[1], Paulo Mazzafera[2] and Marinez Muraro Alves de Lima[1]

Abstract

The coffee germplasm bank of the Instituto Agronômico de Campinas has many *Coffea arabica* accessions from Ethiopia, which is considered the primary center of genetic diversity in coffee plants. An evaluation of the caffeine content of beans from 99 progenies revealed intra- and inter-progeny variability. In 68 progenies from the Kaffa region we found caffeine values in the range 0.46-2.82% (mean 1.18%), and in 22 progenies from Illubabor region these values ranged from 0.42 to 2.90% (mean 1.10%). This variability could be exploited in a breeding program aimed at producing beans with low-caffeine content.

INTRODUCTION

Although coffee is a popular beverage mostly due to the alertness caused by caffeine, there is an increasing market for decaffeinated coffee (Mazzafera *et al*., 1997). Organic solvents or supercritical carbon dioxide is used to decaffeinate coffee, with the final product containing less than 0.5% caffeine (Mazzafera and Carvalho, 1991; Saldaña *et al*., 1998). Supercritical extraction produces coffee free from chemical residues, the presence of which limits coffee consumption (Mazzafera and Carvalho, 1991). Supercritical extraction also has the advantage of being selective for caffeine without changing the final product quality, although recent studies have shown that other substances, such as sugars, oil and phenolic compounds (Saldaña, M.D.A., Mohamed, R.S. and Mazzafera, P., unpublished data), are also extracted during the process (Peker *et al*., 1992; Saldaña, 1997).

The Arabica coffee bean cultivar "Laurina" has half the content (0.6%) of caffeine found in other *Coffea arabica* cultivars (1.2%) (Carvalho *et al*., 1965), and differs from the latter in its peculiar plant architecture and low productivity (Carvalho *et al*., 1991). Carvalho *et al*. (1965) showed that these characteristics are recessive (*lrlr*), with a strong pleiotropic effect.

Mazzafera *et al*. (1992) evaluated the caffeine content of more than 500 coffee trees of *C. arabica* under selection for productivity and pest and disease resistance and observed little variability in the caffeine content. Breeding programs involving interspecific crosses among *C. arabica* and low-caffeine content African species resulted in hybrids with a low-caffeine content but with poor vegetative characteristics (Mazzafera and Carvalho, 1992). Problems resulting from strong genetic barriers between *C. arabica* and other native diploid *Coffea* species from the Mascarene Islands and Madagascar have been reported (Charrier, 1978; Charrier and Berthaud, 1975; Rakotomalala *et al*., 1992).

The production of low-caffeine coffee bean varieties, using traditional plant breeding methods, is slow and arduous. However, considering the problems associated with the methods of caffeine extraction currently used, the breeding of such plants is still a desirable solution. In the present work, we analyzed Arabica germplasm, originally introduced from Ethiopia, considered to be the primary center of genetic diversity in coffee plants (Medina Filho *et al*., 1984). The most promising genotypes could be valuable in a breeding program aimed at producing beans with a low-caffeine content, and would help to expand the limited genetic variability of Brazilian coffee (Medina Filho *et al*., 1984).

MATERIAL AND METHODS

The *Coffea arabica* plants studied were originally collected from seven regions in Ethiopia during an FAO expedition in 1964-65 (FAO, 1968). The plants were grown in Turrialba, Costa Rica, and transferred in 1975 to the germplasm bank of the Experimental Center of the Instituto Agronômico de Campinas (IAC).

Seeds from 724 plants were analyzed, of which 68 were progenies from the Kaffa region, 22 from Illubabor, five from Gojjam and one each from Eritrea, Geisha, Harar and Shoa. The Brazilian cultivars "Catuaí Vermelho" and "Mundo Novo" (24 plants) were included for comparison. Coffee beans were obtained from at least 20 mature fruits of each plant, and their caffeine content determined by high-performance liquid chromatography (Mazzafera *et al*., 1997), following extraction.

[1]Centro de Café e Plantas Tropicais, Instituto Agronômico de Campinas, Caixa Postal 28, 13001-970 Campinas, SP, Brasil. Send correspondence to M.B.S.
[2]Departamento de Fisiologia Vegetal, Instituto de Biologia, Universidade Estadual de Campinas (UNICAMP), Caixa Postal 6109, 13083-970 Campinas, SP, Brasil.

RESULTS AND DISCUSSION

The mean caffeine content of 499 plants from the Kaffa region was 1.18% (Table I), although there was high intra- and inter-progeny variability. Mean caffeine contents as low as 0.46% and as high as 2.82% were found.

In the 166 plants from the Illubabor region, caffeine content ranged from 0.42 to 2.90% (Table II). The plants from Gojjam, Eritrea, Geisha, Harar and Shoa (Table III) did not show the extreme values seen in the other two regions, probably because of the small number of plants analyzed.

These results show that some Ethiopian plants have a caffeine content lower than those of the reference cultivars "Catuaí Vermelho" and "Mundo Novo". However, the low productivity of the Ethiopian germplasm (Carvalho, A., Fazuoli, L.C. and Guerreiro Filho, O., unpublished data) limits their use and would require a hybridization program to produce high-yield cultivars.

The identification of some Ethiopian genotypes with a low-caffeine content confirms previous reports on the genetic variability of these accessions for a number of traits. Carvalho *et al*. (1983) reported variability in fruit shape, size, weight and color, and Mazzafera *et al*. (1989) identified male-sterile plants. In an early study, Carvalho (1959) evaluated a group of Ethiopian plants introduced to Brazil in 1952 and 1953 and identified additional factors of economic interest, such as the recessive allele "semi-erecta", which is responsible for a change in the lateral branch intersection of the stems. Plants with coffee leaf rust resistance were also identified.

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Table I - Caffeine content (%) of beans from 68 *Coffea arabica* progenies from the Kaffa region of Ethiopia, compared with two Brazilian cultivars (Catuaí Vermelho and Mundo Novo).

Progeny	N	Caffeine content (%)			Standard error	Progeny	N	Caffeine content (%)			Standard error
		Mean	Minimum	Maximum				Mean	Minimum	Maximum	
2128	2	0.81	0.76	0.85	—	2134	8	1.20	0.93	1.62	0.24
2158	3	0.85	0.59	1.18	0.30	2161	12	1.21	0.98	1.47	0.13
2267	4	0.90	0.74	1.32	0.28	2160	9	1.22	0.91	1.46	0.17
2275	3	0.91	0.72	1.15	0.22	2201	4	1.22	1.01	1.44	0.18
2194	8	0.94	0.74	1.12	0.14	2195	7	1.23	0.97	1.55	0.20
2182	9	0.97	0.84	1.09	0.08	2139	14	1.24	0.97	1.76	0.21
2131	5	1.00	0.63	1.41	0.32	2281	5	1.24	1.01	1.40	0.15
2123	6	1.00	0.78	1.21	0.16	2130	2	1.25	1.12	1.37	—
2156	9	1.01	0.93	1.16	0.07	2143	3	1.25	1.22	1.30	0.04
2183	10	1.02	0.83	1.21	0.12	2184	8	1.26	1.10	1.44	0.11
2132	12	1.02	0.80	1.26	0.17	2152	3	1.26	1.20	1.37	0.10
2164	12	1.04	0.65	1.66	0.23	2141	10	1.29	1.03	1.81	0.25
2162	6	1.04	0.46	1.34	0.32	2282	14	1.29	0.86	2.43	0.36
2180	10	1.05	0.57	1.35	0.21	2159	4	1.30	1.18	1.40	0.09
2189	7	1.05	0.77	1.23	0.18	2208	12	1.30	0.76	1.89	0.32
2153	12	1.05	0.79	1.51	0.23	2125	3	1.31	1.03	1.59	0.28
2179	7	1.06	0.79	1.30	0.16	2135	2	1.31	1.05	1.56	—
2192	9	1.08	0.84	1.35	0.15	2163	12	1.32	0.84	1.59	0.25
2199	17	1.08	0.61	1.48	0.24	2133	4	1.34	1.17	1.53	0.19
2155	14	1.08	0.86	1.25	0.12	2118	2	1.35	1.20	1.50	—
2154	4	1.11	1.06	1.17	0.05	2137	5	1.35	1.06	1.56	0.20
2186	6	1.11	0.72	1.68	0.40	2146	2	1.35	1.26	1.43	—
2151	6	1.12	0.97	1.34	0.15	2127	10	1.36	0.86	1.99	0.36
2191	8	1.12	0.93	1.40	0.15	2126	3	1.37	1.21	1.52	0.16
2136	6	1.13	0.87	1.62	0.28	2124	7	1.38	0.95	2.05	0.34
2138	8	1.13	0.90	1.31	0.12	2268	5	1.39	1.22	1.52	0.14
2276	3	1.13	1.04	1.24	0.10	2181	10	1.42	0.84	2.14	0.36
2157	6	1.13	1.01	1.26	0.10	2197	12	1.45	1.09	2.35	0.32
2190	3	1.13	1.06	1.19	0.07	2277	5	1.46	0.85	2.82	0.78
2129	12	1.14	0.77	1.45	0.20	2270	6	1.53	0.80	2.55	0.57
2188	10	1.14	0.66	2.47	0.55	2142	5	1.65	1.20	2.45	0.48
2198	10	1.16	0.96	1.39	0.15						
2200	6	1.16	1.04	1.24	0.09	Total	499	1.18	0.46	2.82	
2196	10	1.16	0.66	1.70	0.30						
2193	9	1.17	0.81	1.38	0.20						
2185	11	1.19	0.88	1.53	0.23	Catuaí Vermelho	15	0.93	0.62	1.45	0.25
2187	8	1.20	0.96	1.53	0.20	Mundo Novo	9	1.33	0.96	2.19	0.45

Table II - Caffeine content (%) of beans from 22 *Coffea arabica* progenies from the Illubabor region of Ethiopia.

Progeny	N	Caffeine content (%)			Standard error
		Mean	Minimum	Maximum	
2170	12	0.76	0.42	1.03	0.18
2171	5	0.94	0.82	1.08	0.11
2168	9	0.95	0.70	1.17	0.16
2166	11	0.97	0.80	1.16	0.12
2169	12	0.99	0.64	1.24	0.18
2175	9	0.99	0.67	1.33	0.22
2147	9	1.00	0.91	1.09	0.06
2176	4	1.01	0.82	1.36	0.24
2178	6	1.02	0.83	1.19	0.16
2165	9	1.03	0.82	1.17	0.12
2145	6	1.05	0.75	1.29	0.22
2148	7	1.07	0.75	1.34	0.22
2174	6	1.07	0.75	1.56	0.30
2167	5	1.07	0.91	1.21	0.12
2173	8	1.12	0.98	1.34	0.13
2146	12	1.15	0.98	1.48	0.16
2279	4	1.15	0.92	1.34	0.18
2177	6	1.18	0.67	2.51	0.67
2149	8	1.30	0.99	1.60	0.21
2172	9	1.38	1.07	1.65	0.22
2144	4	1.46	0.99	2.07	0.52
2150	5	1.53	1.11	2.90	0.78
Total	166	1.10	0.42	2.90	

Table III - Caffeine content (%) of beans from five *Coffea arabica* progenies from the Gojjam region and one progeny from each of the other four Ethiopian regions.

Progeny	N	Caffeine content (%)			Standard error
		Mean	Minimum	Maximum	
2202	7	0.89	0.67	1.16	0.18
2205	8	0.92	0.77	1.12	0.11
2204	7	1.01	0.71	1.17	0.16
2203	8	1.04	0.80	1.34	0.17
2206	9	1.04	0.71	1.99	0.38
Total	**39**	**0.98**	**0.67**	**1.99**	
2210 G	8	0.93	0.62	1.16	0.22
2207 E	8	0.95	0.74	1.14	0.16
2026 H	2	1.18	1.08	1.29	-
2036 S	2	1.42	1.33	1.50	-

G = Geisha; E = Eritrea; H = Harar, and S = Shoa.

RESUMO

O banco de germoplasma de café do Instituto Agronômico de Campinas contém grande número de introduções de *Coffea arabica* provenientes da Etiópia, considerada centro de diversidade genética desta espécie. A avaliação dos teores de cafeína nas sementes de 99 progênies revelou a presença de variabilidade entre e dentro das progênies, de acordo com a região de origem das introduções. Entre as 68 progênies da região de Kaffa encontraram-se valores de cafeína entre 0.46 e 2.82% (média 1.18%) e entre as 22 progênies de Illubabor obtiveram-se plantas cujos teores de cafeína variaram de 0.42 a 2.90% (média 1.10%). A variabilidade aqui relatada poderá ser explorada na produção de uma variedade de café com baixos teores de cafeína nas sementes.

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