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Chemical variation in essential oil constituents of *Platonia insignis* Mart. From North of Brazil

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Abstract
Platonia insignis (Clusiaceae), a native tree of Amazon produces fruit largely used in some food. Although extensively research on free fatty acids and volatiles of the pulp, shell and seeds, no paper was encountered concerning volatiles from the leaves of this species. Essential-oil samples were extracted from fifteen individual plants of *Platonia insignis* from representative wild populations from three municipalities in the Northeastern Pará, Brazil, and investigated by gas chromatography/mass spectrometry (GC/MS) and gas chromatography/flame ionization detector (GC/FID). The results of the oil compositions were processed by Hierarchical Component Analysis (HCA) allowing establishment of two groups of essential oils differentiated by the content of β-caryophyllene (Cluster I), and α-selinene/β-selinene (Cluster II). HCA also distinguished the oils taken from the Mosqueiro Island from the oils from Bragança and Santo Antonio do Tauá during the dry and rainy Amazonian seasons.

Keywords: Chemical variation, essential oil constituents, *Platonia insignis,* Brazil

1. Introduction

Bacuri (*Platonia insignis* Mart.) belonging to the Clusiaceae family, is one of the most popular fruit of the State of Pará. In all Amazon, this species showed large concentration in the Salgado and in the Marajó Island (Cavalcante, 2010). In the State of Pará, was dispersed in the direction to the northeast of Brazil, reaching of the States to Maranhão and Piauí; in south direction, the dispersion reached the States of Tocantins and Mato Grosso, getting to break the borders of Brazil; in the north direction it reached the State of Amapá, also happening, although in a rare area way, in the State of Amazonas (Cavalcante, 2010; Nascimento *et al*., 2007). Bacuri is found in abundance in the markets of Belém in the months of February and March.

Oleic (39.0%), palmitic (28.0%) and stearic (28.0%) acids were identified in the fat of the seed of *P. insignis* for the first time by Pechnick and Chaves (1945). The predominance of palmitic and oleic acids in seed, pulp and shells of bacuri fruit also was reported by other researchers (Hilditch and Pathak, 1949; Bentes *et al*., 1986/1987; Guedes *et al*., 1990; Rogez *et al*., 2004). Concerning the volatile compounds Alves and Jennings (1979) identified heptane, linalool, *cis*-linalool oxide and *trans*-linalool oxide as a major constituents encountered in the pasteurized pulp of bacuri fruit. Extraction of bacuri shells by different methods (LCO_2, SCO_2, SD, EtOH at room temperature and in Soxhlet) showed the presence of free fatty acids, linalool, 3,7-dimethyl-1-octen-3,7-diol, eugenol, β-bisabolene, α-terpineol, methyl benzene, *trans*-linalool oxide, *cis*-linalool oxide and trimethyl citrate (Monteiro *et al*., 1997). Linalool and its *cis*-furanoid oxide, 2,6-dimethyl-octa-3,7-dien-2,6-diol (isomer 2) were encountered in a major amount of the pulp fruit (Boulanger *et al*., 1999). In the same way, considering the volatile compounds present in the bound fraction, released by enzymatic hydrolysis of the crude heterosidic extract, 2-phenylethanol had the highest concentration (Boulanger *et al*., 1999; Franco and Janzantti, 2005). Linalool and α-terpineol were the most prominent compounds encountered in the SDE-extract of the pulp of bacuri fruits taken in the open Ver-o-Peso market in the city of Belém (Borges and Rezende, 2000). The formation of volatile constituents during heat treatment of bacuri pulp at the natural pH of the fruit was reported (Boulanger and Crouzet, 2001). Linalool, hotrienol, *cis*-linalool furanoxide and *trans*-linalool furanoxide were major in pH = 3 then compared to pH = 7, in SDE extraction (Boulanger and Crouzet, 2001). Linalool is the compound responsible for the most intense aroma and floral characteristic of the pulp of bacuri fruit, while the contribution of a fruity note was assigned to the ester methyl hexanoate (Borges and Rezende, 2000). A survey of literature reveals no existence of the studies on leaf volatiles of *P. insignis*. The aim of the present paper was to characterize the volatiles present in the leaves of *P. insignis* from three populations that grown wild in three municipalities in the Northeastern of the State of Pará, and investigate the chemical variability in the function of the place of collection and the influence of the seasonal period.

2. Experimental Part

For this research fifteen natural specimens of three municipalities in the State of Pará were selected: Area I is located in the Community of Benjamin Constant belonging to the municipality of Bragança located between the geographical coordinates: 1 ° 00 '00 "and 1 ° 10' 00 'south latitude and 46 ° 40' 00 'and 46 ° 50' 00 "west longitude of Greenwich (Figure 1); area II is the São Caetano of Maynooth, northeastern Pará, Microrregião Salgado and displays geographic coordinates: 00º 44 '33 "South latitude and 48 01' 03" longitude west of Greenwich. Limited to: the North - Atlantic Ocean in the east - Municipalities Curuçá, São João da Ponta and Terra Alta, the South - City Watch and the West - City Watch (Figure 1) and area III is located between geographical coordinates: 1 4 '11 "to 1 13' 42" South latitude and 48 19 '20 "to 48 ° 29' 14" longitude west of Greenwich, covering an approximate area of 220 km2, with an average altitude of 15 m above sea (Figure 1). Integral part of the city of Bethlehem, the Mosqueiro Island is located on the right portion of the Estuary Guajarino, with approximately 220 km2, contained in the northeastern state of Para (SALES, 2005) region. Samples were collected from five trees of each area, during the summer and winter amzônico for two consecutive years. Botanical identification was made in the herbarium of the Goeldi Museum, in comparison with the voucher # 62195. After extraction, the samples were dried for 7 days in a room with air conditioning (low humidity) and then ground.

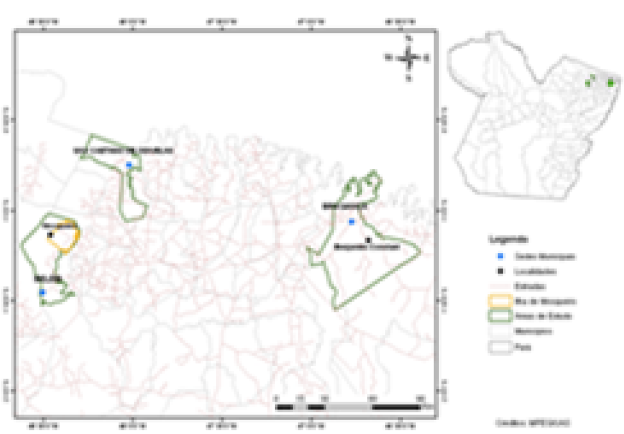

Fig 1: Locality of collection of fifteen samples of P. insignis.

Extraction of volatiles. The dry plant material was hydrodistilled for 3h, using a Clevenger-type apparatus. The oils obtained were centrifuged for 3min in 3000 rpm, dried over anhydrous sodium sulphate and centrifuged again at the same conditions. Yield was calculated in mL/100g of dried material. Residual water present in the dried samples was obtained by infrared in a MATER-50 equipment. The solutions containing 2µL of the oil in 1mL of hexane were immediately prepared to gas chromatography analysis. The samples taken in Bragança in the rainy season also were submitted to the extraction by SDE (simultaneous-distillation extraction). Samples of dried leaves (100 g each) was mixed with water (20 mL) and submitted to SDE for 3 h, using a Chrompack Micro-steam Distillation Extractor and pentane (2 mL) as organic mobile phase, and immediately submitted to GC and CG/MS analysis.

Analysis of the volatiles. GC/MS: The oils were analyzed using a Shimadzu GC/MS Model QP 2010 Plus, equipped with a Rtx-5MS (30 m x 0.25 mm; 0.25 µm film thickness) fused silica capillary column. Helium was used as carrier gas adjusted to 1.2mL/min at 57KPa; splitless injection of 1 µL, of a hexane solution; injector was 250°C and detector temperature was 250°C; oven temperature programmed was 60–240°C at 3°C/min, interface of the detector was 250°C. EIMS: electron energy, 70 eV; ion source temperature and connection parts: 250°C. The Individual components were identified by comparison of both mass spectrum and their GC retention indices with those in the data system libraries and cited in the literature (Adams, 2007). Retention indices were calculated according Van den Dool and Kraft (1963). *GC:* This was performed on a Shimadzu QP-2010 instrument, equipped with FID, in the same conditions, except hydrogen was used as the carrier gas. The percentage composition of the oil samples were computed from the GC peak areas without using correction for response factors.

3. Results and discussion

For the 15 specimens were obtained 30 essential oils, and 5 pentane concentrate. In total, 106 different compounds were identified. Tables 1 - 3 gives the volatiles identified in the 30 oils obtained from 15 samples collected in the three selected municipalities. Table 4 shows the chemical composition of the five samples taken in Bragança in the rainy season, obtained by SDE. All oils from the three localities studied showed 0.05% yield in dry and rainy seasons. All oils from the leaves of *P. insignis* were terpenoid in nature, but aldehydes, fatty acids, alcohols and other compounds were encountered as minor constituents. No significant differences between individual chemical components encountered in the samples taken in the same locality have been observed. In the same, samples taken in the two different Amazonian seasons showed high similarity within the same season. The oils extracted from the plants growing in the municipality of Bragança and São Caetano de Odivelas showed a similar chemical composition, characterized by the presence of β-caryophyllene as a major constituent, while the oils from Mosqueiro were characterized by the occurrence of α-selinene and β-selinene as a major constituents. However, considerable quantitative variation was noted when compared the volatiles on dry and rainy seasons. In the oils from Bragança β-caryophyllene changed from 9.29% to 13.13% in the dry season, and from 16.49% to 22.99% during rainy season; in the oils from São Caetano de Odivelas, β-caryophyllene changed from 22.99% to 33.25% in the dry season, and from 13.13% to 15.08% during rainy season; in the oils from Mosqueiro Island, β-selinene changed from 8.54% to 11.82% in dry season and from 18.82% to 23.75% in rainy season. Among the 108 constituents only linalool, β-cyclocitral, α-copaene, β-bourbonene, β-caryophyllene, *trans*-α-bergamotene, γ-cadinene, and (3*Z*)-hexenyl benzoate were encountered in all samples analyzed.

From those 92 components identified in the thirty essential oil samples submitted to multivariate analysis using HCA, two well-defined clusters of essential oils were differentiated (Figure 2). Cluster I, composed by the samples from Bragança and São Caetano de Odivelas, and Cluster II, composed by the samples from Mosqueiro. Cluster I was divided in four subclusters represented by the samples taken in two localities and in the two Amazonian seasons. Subcluster Ia and Ib were composed by the samples from Bragança in dry season and rainy season, respectively. Subcluster Ic and Id were formed by the samples taken in São Caetano de Odivelas, in dry season and rainy season, respectively. In the same way, Subclusters IIa and IIb were composed by the samples taken in the Mosqueiro Island in dry season and rainy season, respectively. Extraction by DES allowed the identification of 69 compounds, among them (2*E*)-hexenal (9.99% - 27.51%) and β-caryophyllene (12.79% - 17.53%) were major. (2*E*)-Hexenal was best extracted by SDE (9.99 – 27.51%), then compared to those obtained by HD (zero – 2.47%) for the samples from Bragança, in the rainy season. (3*E*)-Hexenal, hexanoic acid, acetophenone, benzyl alcohol, heptanoic acid, *trans*-linalool furanoxide, 4-vinyl-4-methoxyphenol, eugenol, γ-nonalactone, *allo*-aromadendrene, hexadecanal, (3*Z*)-hexenyl cinnamate, heptadecanal and octadecanal also identified in pentane concentration obtained by SDE. Comparison of our results obtained from the leaves of *P. insignis* by SDE with the data presented by Borges and Rezende (2000) for the pulp volatiles reveals both similarities and differences: they found linalool (24.1%), α-terpineol (12.0%), *trans*-linalool furanoxide (11.1%) and *cis*-linalool furanoxide (6.1%) as a major compounds. In the leaf pentane concentrate from Bragança (rainy season), (2*E*)-hexenal (9.99 – 27.51%) and β-caryophyllene (12.79 – 17.53%) were identified as a major compounds, following by linalool (1.11 – 5.93%) and δ-cadinene (5.42 – 6.84%). In the same way, (2*E*)-hexenal, limonene, (*E*)-β-ocimene, *cis*-linalool furanoxide, *trans*-linalool furanoxide, α-terpineol, geraniol, *trans*-α-bergamotene and β-ionone also were detected in the pulp submitted SDE by Boulanger *et al*. (1999). The main components of leaf essential oil of *P. insignis* were confirmed to be β-caryophyllene, β-selinene, and α-selinene. HCA showed the existence of a highly intra-specific variability within the essential oil of *P. insignis*, and separates the oils obtained from individuals taken in Bragança and São Caetano de Odivelas of the individuals taken in Mosqueiro Island.

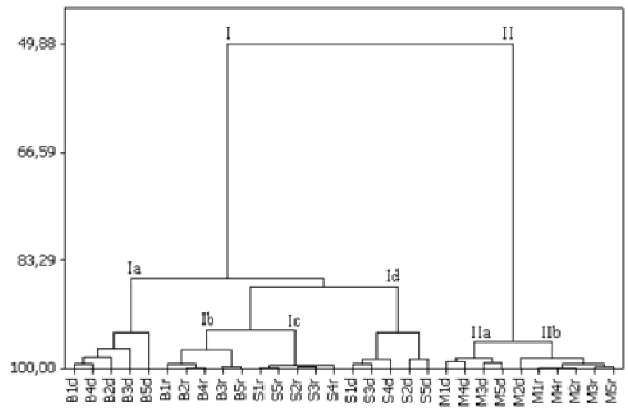

Fig 2: Hierarchical Component Analysis (HCA) of *Platonia insignis* plants collected from three populations from North of Brazil, in the dry and yet Amazon seasons. B1d-B5d = Bragança-dry season, B1r-B5r = Bragança-rainy season; S1d-S5d = São Caetano de Odivelas-dry season; S1r-S5r = São Caetano de Odivelas-rainy season, M1d-M5d = Mosqueiro-dry season; M1r-M5r = Mosqueiro-rainy season.

Table 1: Constituents (%) identified in the leaf essential oils of *Platonia insignis* growing wild in the municipality of Bragança in the dry and rainy Amazonian seasons

Constituents	Dry season					Rainy season				
	1ds	2ds	3ds	4ds	5ds	1rs	2rs	3rs	4rs	5rs
(2*E*)-hexenal	1.01	1.43		0.77	0.89			0.98		2.47
limonene	0.42	0.64	0.27	0.52	0.39			0.31		0.37
(*Z*)-β-ocimene	0.20	0.32	0.12	0.26	0.2			0.22		0.26
(*E*)-β-ocimene	0.54	1.12	0.36	0.65	0.55	0.30		0.90		1.04
cis-linalool furanoxide	0.07	0.13		0.15	0.21					
terpinolene	0.35	0.51	0.22	0.45	0.41			0.30		0.33
linalool	3.02	4.03	1.12	3.84	3.86	4.29	1.04	6.94	1.29	7.63
allo-ocimene	0.10	0.17	0.06	0.13	0.11					
(2*E*,6*Z*)-nonadienal	0.14	0.27	0.04	0.17	0.17			0.39	0.24	0.32
(2*E*)-nonenal	0.18	0.26	0.07	0.20	0.18			0.21	0.18	0.13
octanoic acid	0.25	0.37	0.05	0.26	0.35			0.56		
α-terpineol	0.62	0.95	0.16	0.87	0.99	0.48	0.15	0.93	0.15	0.88
safranal	0.07	0.11	0.02	0.08	0.06			0.23		0.23
β-cyclocitral	0.16	0.23	0.05	0.15	0.17		0.27	0.32	0.28	0.31
nerol	0.39	0.59	0.11	0.54	0.60			0.39		0.35
(3*Z*)-butanoate 3-methylhexenyl								0.13		0.12
geraniol	0.92	1.27	0.27	1.21	1.29	0.49		0.76		0.62
(2*E*)-decenal	0.15	0.16	0.08	0.16	0.15					
geranial	0.03	0.05		0.03	0.04					
safrole							0.47		0.33	
(3*Z*)-hexenyl tiglate						0.36		0.31		0.28
δ-elemene	0.14	0.16	0.11	0.13	0.14					
α-cubebene	1.99	1.81	2.20	1.79	1.71	3.57	3.00	2.73	2.99	2.77
α-ylangene	0.42	0.39	0.30	0.36	0.28		0.48	0.41		
α-copaene	3.81	3.55	3.96	3.21	2.97	8.93	8.31	6.37	9.00	7.18
β-bourbonene	1.90	2.76	1.27	1.49	1.03	5.90	6.14	4.72	5.67	4.72
α-gurjunene	0.88	0.99	0.75	0.77	0.70	0.99	0.91	0.90	1.06	0.77
β-caryophyllene	11.36	9.53	13.13	10.92	9.29	22.99	20.62	16.94	22.55	18.44
β-gurjunene	1.28	1.29	1.21	1.03	1.13	1.77	2.17	2.10	1.77	1.55
trans-α-bergamotene	1.65	1.95	1.67	1.51	1.29	2.22	4.11	1.42	4.09	1.98
α-guaiene	0.90	1.02	0.88	0.75	1.08	0.86	0.96	0.75	0.99	0.80
α-humulene	3.46	3.02	3.93	3.43	2.84	5.60	5.80	4.96	6.31	5.17
cis-cadina-1(6),4-diene	0.53	0.61	0.49	0.44	0.47					

trans-cadina-1(6),4-diene	1.27	1.22	1.34	1.06	1.01					
γ-muurolene	1.86	1.65	1.94	1.49	1.46	3.95	3.89	3.37	4.12	3.51
germacrene D	1.33	1.34	1.53	1.11	1.28	1.78	1.38	1.43	1.49	1.40
(*E*)-β-ionone						0.94	0.99	0.85	1.08	0.86
viridiflorene	2.15	2.10	2.31	1.84	1.76	2.50	2.90	2.16	2.65	2.20
α-muurolene	1.54	1.46	1.63	1.28	1.31	1.82	1.80	1.65	1.92	1.64
(*E*,*E*)-α-farnesene	2.08	2.78	2.64	1.88	2.97					
γ-cadinene	1.74	1.86	1.68	1.39	1.56	1.72	1.72	1.51	1.76	1.59
δ-cadinene	5.00	4.41	5.48	4.09	3.82	8.30	8.34	6.73	8.51	7.15
trans-cadina-1,4-diene	0.89	0.91	0.87	0.73	0.74	1.13	1.09	1.03	1.11	1.04
α-cadinene	0.63	0.61	0.63	0.53	0.54	0.58	0.53	0.47	0.62	
α-calacorene	0.91	0.95	0.90	0.82	0.72	0.76	0.98	0.75	1.01	1.21
(*E*)-nerolidol	1.96	1.75	2.09	1.93	2.40	1.03	1.21	1.19	1.24	1.1
(3*Z*)-hexenyl benzoate	0.99	1.27	0.80	0.81	1.10	1.73	1.92	1.58	1.13	1.47
dendrolasin	1.78	1.12	1.85	1.59	1.40					
gleenol	1.16	1.63	1.54	1.18	1.25	1.26	1.19	1.42		
viridiflorol	1.12	1.05	1.13	1.12	0.92		1.00			0.57
humulene epoxide II	0.39	0.43	0.36	0.38	0.38					
1,10-di-*epi*-cubenol	0.38	0.34	0.38	0.43	0.31					
1-*epi*-cubenol	1.67	1.41	1.55	1.61	1.28	1.15	1.32	1.51	1.01	1.10
cis-cadin-4-en-7-ol	0.53	0.45	0.45	0.49	0.45					
caryophylla-4(12),8(13)-dien-5-ol	0.28	0.29		0.27	0.28					
epi-α-muurolol	2.47	1.78	2.82	2.57	1.81					
cubenol						1.32	1.28	1.69	1.08	1.28
α-muurolol	0.90	0.82	0.79	0.88	0.74					
α-cadinol	2.47	1.84	2.44	2.73	1.98	1.12	0.72	1.24	0.85	1.07
cadalene	0.24	0.27	0.29	0.24	0.22		0.27			
nonadecane	0.02	0.04	0.04	0.03						
hexadecanoic acid	1.79	2.04	3.24		5.75					
(5*E*,9*E*)-farnesyl acetone							0.25		0.18	
ethyl linoleate	0.25	0.16	0.26	0.29	0.34					

ds = dry season, rs = rainy season

Table 2: Constituents (%) identified in the leaf essential oils of *Platonia insignis* growing wild in the municipality of São Caetano de Odivelas in the dry and rainy Amazonian seasons.

Constituents	Dry season					Rainy season				
	1ds	2ds	3ds	4ds	5ds	1rs	2rs	3rs	4rs	5rs
(2*E*)-hexenal						0.47	0.76	0.49		0.54
limonene						0.04	0.07	0.07	0.05	0.07
(*Z*)-β-ocimene		0.94				0.03	0.04	0.05	0.03	
(*E*)-β-ocimene		3.87		3.93	2.79	0.06	0.08	0.17	0.14	0.08
terpinolene		0.57				0.06	0.10	0.09	0.07	0.06
linalool	4.05	6.13	1.42	5.74	3.69	0.71	1.75	1.77	0.38	1.15
allo-ocimene							0.03	0.03	0.02	
(2*E*,6*Z*)-nonadienal						0.11	0.13	0.13	0.08	0.16
(2*E*)-nonenal						0.15	0.13	0.14	0.13	0.17
octanoic acid						0.21	0.26	0.19	0.14	0.26
α-terpineol		0.50			0.32	0.08	0.23	0.18	0.05	0.15
safranal						0.06	0.06	0.04	0.06	0.05
β-cyclocitral		0.24			0.25	0.13	0.14	0.15	0.12	0.14
nerol						0.05	0.13	0.11		0.07
neral							0.01			0.01
geraniol						0.09	0.27	0.24	0.06	0.16
(2*E*)-decenal						0.11	0.09	0.09	0.13	0.1
geranial						0.02	0.03	0.02	0.01	0.03
safrole			0.49			0.04	0.03	0.02	0.04	0.03
isobutyl benzoate						0.03	0.02	0.03	0.03	0.03
δ-elemene						0.37	0.31	0.37	0.45	0.36
α-cubebene						1.15	1.01	1.10	1.23	1.05
α-ylangene		0.36			0.35	0.10	tr	0.53	tr	tr
α-copaene	3.99	2.98	4.83	3.19	2.87	6.65	5.42	5.00	5.93	5.81
β-bourbonene	6.18	4.31	7.53	5.78	4.02	5.10	4.49	5.14	5.62	5.27
β-elemene						0.61	0.50	0.45		0.54
α-gurjunene						0.89	0.88	0.86	1.06	0.90
β-caryophyllene	31.61	22.99	33.25	29.81	25.14	13.93	13.13	14.63	15.08	13.19
β-gurjunene	2.34	1.76	2.67	2.11	1.52	2.14	1.88	2.17	2.59	2.05
trans-α-bergamotene	2.21	3.18	2.26	3.07	3.97	0.88	0.90	0.99		1.00
aromadendrene	0.73	0.51	0.81	0.58	0.51	1.01	0.90	0.90	0.97	1.01
α-humulene	5.70	4.88	5.89	5.16	5.37	4.31	4.82	4.37	5.46	4.19

cis-cadina-1(6),4-diene						0.95	0.82	0.84	0.90	0.94
trans-cadina-1(6),4-diene						1.21	1.16	1.21	1.40	1.19
γ-muurolene	3.23	2.60	3.27	2.72	2.59	3.10	2.85	2.96	3.09	3.06
germacrene D						2.03	1.83	2.02	1.96	2.23
β-selinene	1.12	1.10	1.15	1.06	1.16	1.86	1.50	1.46	1.48	1.44
viridiflorene	3.1	2.54	3.13	2.64	2.58	4.42	3.98	3.47	4.26	4.34
α-muurulene	1.52	1.29	1.53	1.29	1.35	1.51	1.42	2.04	1.54	1.6
(*E,E*)-α-farnesene	3.64	4.45	2.57	3.59	4.67					
γ-cadinene	1.79	1.29	1.77	1.53	1.66	2.36	2.35	2.27	2.3	2.46
δ-cadinene	6.06		6.16	5.14	5.48	5.53	5.28	5.68	5.56	5.55
trans-cadina-1,4-diene						1.15	1.14	1.14	1.32	1.24
α-cadinene						0.72	0.70	0.70	0.77	0.76
α-calacorene						0.93	0.99	0.97	0.96	1.03
(*E*)-nerolidol	1.01	1.12	1.78	0.98	1.55					
(3*Z*)-hexenyl benzoate	2.23	1.16	1.87	1.16	1.91	1.03	1.08	1.04	1.11	
dendrolasin	7.38	11.33	3.11	5.86	15.56	2.03	1.60	2.06	1.45	1.67
caryophyllene oxide						2.29	2.53	2.47	2.44	2.22
globulol						0.99	1.05	0.97	1.01	0.95
rosifoliol						1.12	1.22	1.11	1.13	1.09
humulene epoxide II						0.57	0.65	0.61	0.62	0.62
1,10-di-*epi*-cubenol						0.37	0.38	0.34	0.33	0.35
dillapiol	3.07	1.29	3.30	6.43	1.17					
1-*epi*-cubenol						1.09	1.26	1.21	1.23	1.19
caryophylla-4(12),8(13)-dien-5-ol						0.65	0.69	0.65	0.62	0.73
epi-α-muurulol						1.67	1.94	1.77	1.79	1.81
α-muurolol						0.71	0.78	0.68	0.68	0.71
α-cadinol						1.65	2.04	1.74	1.77	2.48
cadalene						0.27	0.28	0.25	0.28	0.25
14-oxi-α-muurolene						0.15	0.19	0.07	0.15	0.15
hexadecanol						0.11	0.13	0.08	0.13	0.10
nonadecane						0.03	0.02	0.02	0.02	0.03
(5*E*,9*E*)-farnesyl acetone						0.34	0.37	0.23	0.31	0.31
fitol						0.09	0.2	0.11	0.10	0.08
(*E,E*)-geranyl linalool		0.33			0.77	0.53	1.43	1.11	0.66	0.59
octadecanol						0.10	0.13	0.07	0.15	0.11
ethyl linoleate						0.04	0.05	0.02	0.06	0.04

ds = dry season, rs = rainy season, tr = traces

Table 3: Constituents (%) identified in the leaf essential oils of *Platonia insignis* growing wild in the municipality of Mosqueiro in the dry and rainy Amazonian seasons.

Constituents	Dry season					Rainy season				
	1ds	**2ds**	**3ds**	**4ds**	**5ds**	**1rs**	**2rs**	**3rs**	**4rs**	**5rs**
(2*E*)-hexenal	0.73	1.67	0.75							
2-pentyl furan	0.41		0.71	0.47	0.51					
limonene	0.09		0.07	0.07	0.08					
(*Z*)-β-ocimene			0.06	0.05	0.08					
(*E*)-β-ocimene	0.37	0.11	0.62	0.57	0.52					
terpinolene	0.10		0.08	0.09	0.08					
linalool	0.40	0.30	1.03	0.64	0.85	0.20	1.45	1.27	0.56	1.17
allo-ocimene			0.05		0.06					
(2*E*,6*Z*)-nonadienal	0.16		0.22		0.16	0.24	0.58	0.36	0.43	
(2*E*)-nonenal	0.17	0.05	0.24	0.17	0.19	0.14	0.29	0.18		
octanoic acid	0.30						0.64	0.48	0.45	
α-terpineol	0.09	0.09	0.17	0.12	0.23					
methyl salicylate	0.09		0.10	0.05						
safranal	0.09		0.14	0.06	0.09		0.50	0.36	0.22	
β-cyclocitral	0.27	0.11	0.31	0.17	0.24	0.44	0.63	0.51	0.66	0.48
geraniol	0.12	0.06	0.22	0.11	0.21					
(2*E*)-decenal	0.15		0.17	0.11	0.22	0.17		0.15		
geranial	0.10		0.11	0.05	0.11					
safrole	0.21	0.26	0.73	0.61	0.38	0.21	0.26	0.25	0.24	
isobutyl benzoate	0.05		0.11	0.05	0.12					
(3*Z*)-hexenyl tiglate	0.23	0.05	0.13	0.07	0.15			0.16		
δ-elemene	0.16	0.15	0.15	0.15	0.21					
α-cubebene	0.15	0.10	0.18	0.19						
α-ylangene	0.25	0.19	0.32	0.24	tr					
α-copaene	2.15	2.55	2.3	2.57	2.62	1.55	1.62	1.09	1.39	1.25
(3*Z*)-hexenyl hexanoate	0.21	0.14		0.12		0.18	0.25			0.25
β-bourbonene	2.29	2.01	1.74	1.81	1.79	2.22	2.18	2.56	2.59	2.44

β-elemene	7.23	9.11	4.98	6.63	4.91	9.32	7.85	8.86	9.11	11.89
(*Z*)-caryophyllene	0.44	0.34	0.35	0.25	0.55	0.49	0.57	0.41	0.37	0.36
α-gurjunene	0.08		0.09	0.08						
β-caryophyllene	4.78	6.02	4.18	5.17	4.9	6.12	5.69	4.57	5.69	4.80
β-gurjunene	1.26	1.18	1.17	1.16	1.47					
trans-α-bergamotene	1.62	1.15	1.19	1.28	1.57	1.21	2.62	2.57	1.80	2.75
α-guaiene	0.60	0.43	0.46	0.47		0.48	0.50	0.52		
α-humulene	3.15		2.65	3.10	3.30					
(*E*)-β-farnesene	3.15	7.88	2.65	3.10	3.30	9.10	9.35	7.06	7.87	6.67
cis-cadina-1(6),4-diene	0.46	0.35	0.39	0.45						
4,5-di-*epi*-aristolochene	1.34	1.06	1.08	1.1	1.33	1.5	1.42	1.50	1.42	1.5
γ-selinene	5.73	5.13	5.05	5.19	5.93	6.44	6.34	6.49	6.38	7.00
germacrene D				1.39		0.61	0.64	0.81		0.95
β-selinene	11.17	11.82	8.54	9.58	11.12	17.14	16.55	15.01	18.08	18.32
α-selinene	12.40	15.00	10.50	11.89	10.31	22.13	21.48	18.82	22.34	23.75
(*E*,*E*)-α-farnesene	2.24	1.22		2.45						
α-bulnesene						1.14	1.32	1.45	1.28	1.38
γ-cadinene	1.36	1.06	1.32	1.35	1.36	0.92	0.91	0.92	0.88	0.87
7-*epi*-α-selinene	1.10	0.89	0.89	0.96	1.65	1.15	1.05	1.08	1.03	1.13
δ-cadinene	2.46	2.20	2.23	2.57	1.65	2.08	2.02	2.18	2.03	2.11
selina-3,7(11)-diene						0.41	0.38	0.38	0.34	0.32
α-calacorene	0.55	0.31	0.61	0.58	0.61					
(*E*)-nerolidol	1.06	0.79	0.69	0.89	1.06			0.53		
(3*Z*)-hexenyl benzoate	3.08	1.39	2.02	1.27	1.72	1.37	1.45	1.91	1.99	1.14
dendrolasin	1.92	2.61	3.62	4.36	2.63	1.23	1.54	2.39	2.10	2.01
1-*epi*-cubenol	0.55	0.13	0.30	0.21						
epi-α-muurolol	0.72	0.46	1.12	0.74	0.88	0.32				
α-muurolol	0.25	0.14	0.37	0.24	0.28					
selin-11-en-4α-ol	3.65	4.28	4.89	3.56	3.98	4.12	3.12	4.78	3.75	3.77
cadalene	0.12		0.17	0.14						
heptadecane	0.46	0.18	0.35	0.31	0.60		0.34	0.34		
tetradecanoic acid	0.46									
benzyl benzoate	0.32	0.09		0.12						
nonadecane	0.05		0.05							
(5*E*,9*E*)-farnesyl acetone	0.57	0.60	0.59	0.46	0.66	0.36		0.46		
fitol	0.08	0.11	0.18	0.15	0.26					
(*E*,*E*)-geranyl linalool	0.49	0.54		0.51	0.68					
octadecanol	0.05	0.43	0.33	0.15	0.37					

ds = dry season, rs = rainy season, tr = traces

Table 4: Constituents (%) identified in the leaf essential oils of *Platonia insignis* growing wild in the municipality of Bragança in the rain Amazonian seasons, by SDE.

Constituents	1rs	2rs	3rs	4rs	5rs
(3*E*)-hexenal	0.11	0.32	0.30	0.44	
(2*E*)-hexenal	24.05	12.43	20.86	27.51	9.99
hexanoic acid	1.75	2.11	3.02	2.86	3.08
acetophenone					0.24
limonene	0.14				
benzyl alcohol		0.36	0.73		
(*E*)-β-ocimene			0.17		
cis-linalool furanoxide	1.33	0.74	0.73	0.78	0.44
heptanoic acid			0.43		0.54
trans-linalol furanoxide	0.62	0.56	0.62	0.42	0.33
linalool	5.93	3.83	5.63	3.18	1.11
(2*E*,6*Z*)-nonadienal	0.31	0.22			0.42
(2*E*)-nonenal	0.11	0.08			0.18
octanoic acid	0.71	1.27	0.76	0.70	0.91
naphtalene	0.40		0.38	0.33	0.73
α-terpineol	1.06	0.96	1.18	0.87	0.35
safranal		0.11			0.24
β-cyclocitral	0.17	0.41	0.13		0.19
nerol	0.30	0.29	0.37		
geraniol	0.72	0.72	0.89	0.40	0.23
safrole	0.15	0.20		0.39	0.28
4-vinyl-2-methoxyphenol	0.34	0.53	0.36	0.25	0.43
(3*Z*)-hexenyl tiglate	0.22	0.16	0.18		0.09
δ-elemene	0.08				
α-cubebene	1.81	1.91	1.71	1.38	2.46
eugenol	0.09	0.21	0.29	0.62	0.40

γ-nonalactone	0.25	0.40	0.37	0.21	0.32
α-ylangene	0.31	0.41	0.34	0.36	0.52
α-copaene	4.55	4.37	4.77	4.38	6.56
(3*Z*)-hexenyl hexanoate	0.16				
β-bourbonene	3.02	3.36	3.07	2.10	4.61
α-gurjunene	0.38	0.74	0.50	0.67	0.64
β-caryophyllene	14.65	12.79	16.29	16.10	17.53
β-gurjunene	1.04	3.46	1.10	1.12	1.18
trans-α-bergamotene	1.16		1.94	1.51	3.92
aromadendrene	0.46	0.59	0.55	0.72	
α-humulene	3.05	3.96	4.17	4.63	5.09
allo-aromadendrene	0.32	0.45	0.35	0.37	0.31
cis-cadina-1(6),4-diene	0.35	0.47	0.35	0.28	0.62
γ-muurolene	1.56	2.81	2.56	2.67	3.18
germacrene D	1.06	1.36	1.00	0.90	1.14
(*E*)-β-ionone	0.73	0.85	0.78	0.82	0.96
viridiflorene	1.58	2.01	1.66	1.72	2.11
α-muurolene	1.11	1.39	1.08	1.27	1.38
(*E*,*E*)-α-farnesene	0.92	1.39	1.39	1.13	1.15
γ-cadinene	1.15	1.41	1.19	1.24	1.36
δ-cadinene	5.42	6.08	5.70	5.77	6.84
trans-cadina-1,4-diene	0.83	0.91	0.68	0.74	1.14
α-cadinene	0.19	0.48	0.32	0.43	0.21
α-calacorene	0.50	0.82	0.52	0.62	0.86
(*E*)-nerolidol	0.75	1.21	0.87	0.87	1.12
(3*Z*)-hexenyl benzoate	1.30	1.71	1.18	0.94	1.06
dendrolasin	0.79	1.09	1.14	1.03	0.57
gleenol	0.51	1.46	1.01	0.94	1.41
viridiflorol	0.58	1.00	0.51	0.43	0.91
humulene epoxide II	0.12	0.24			0.25
dillapiole				0.23	
1-*epi*-cubenol	0.78	1.65	0.78	0.90	1.21
caryophylla-4(12),8(13)-dien-5-ol	0.10				
α-muurolol	0.91	2.18	0.76	1.03	1.11
cubenol	0.27		0.19	0.27	0.32
α-cadinol	0.70	1.47	0.75	0.90	0.75
cadalene					0.19
heptadecane	0.15	0.49			0.24
hexadecanal	0.12	0.20			0.08
(3*Z*)-hexenyl cinnamate		0.19			
heptadecanal	0.12				
octadecanal	1.20	1.57	0.93	0.38	0.65
(*E*,*E*)-geranyl linalool		0.06			

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