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Chemotypes of turmeric (*Curcuma longa* L.) essential oil from four different states of Brazil

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Abstract

Turmeric or curcuma (*Curcuma longa* L.) is a Zingiberaceae whose essential oil and coloring pigments obtained from the rhizome have been widely used in the food industry and medicine. This study aimed to extract and identify the chemical compounds found in *C. longa* essential oil from rhizomes collected in six different locations of Brazil. The oil extraction was carried out by hydrodistillation technique, using a Clevenger- type apparatus. The chemical constituents were identified by Gas Chromatography coupled to Mass Spectrometry (GC-MS). The principal component analysis (PCA) and the hierarchical cluster analysis (cluster)were done for the obtained data; and the composition of the studied accesses was verified. Three groups of chemotypes were obtained: group I was formed by the accesses of Campo Grande / Indígena-MS, Mara Rosa-GO, Campo Grande-MS and Perobal-PR, and had Ar-turmerone as its main compound; group II, formed by the access of Santa Tereza do Oeste-PR, presented α-costol and α-Phellandrene as the predominant compounds; and group III, the access of Holambra-SP, differed from the others regarding its essential oil chemical composition whose main agents were Curlone, Zingiberene, β-sesquiphellandrene, Humulene epoxide II, cis-α-trans-Bergamotol. The predominant chemical class in all accesses was hydrocarbon sesquiterpenes (Santa Tereza do Oeste-PR and Holambra-SP) and oxygenated sesquiterpenes (the others). This study evidenced the formation of three chemotypes.

Keywords: Saffron; zingiberene metabolites; chemotypes; gas chromatographer coupled to mass spectrometer.

Introduction

Curcuma longa L. is a native plant, belonging to the family Zingiberaceae, found in Southeastern Asia. Popularly known as tumeric, curcumin, Indian saffron (Grandi, 2014), it has been used as a spice in vegetarian and non-vegetarian food preparation, and present digestive properties . Its rhizomes, generally short and branched, are homemade remedies used in popular medicine.

C. longa L. rhizomes also provide the raw material for the preparation and obtention of extracts and essential oil which present biological activities such as antioxidant (Avanço et al., 2017; Nam et al., 2014), anti-inflammatory and antimicrobial (Hamaguchi et al., 2010; Marini et al., 2018), antiviral and anticarcinogenic, antileishmanial (Haddad et al., 2011) activities specially attributed to bioactive principals, mainly due to the presence of phenolic compounds such as thymol, carvacrol, eugenol and curcumin (Fontes, 2018), which acts on the lipid peroxidation reduction, besides increasing the activity of antioxidant enzymes and the neutralization of free radicals (Manikandan et al., 2009).

Although the rhizome is the most interesting part of this plant, this species is very versatile regarding its use, since it can be consumed fresh or dry. In the latter, they are peeled off, dehydrated and ground, producing a golden-color powder which is utilized as a condiment (sauces and seasonings) or as spices (vegetal product) (Ajay Kumar et al., 2016). Therefore, it may substitute some artificial colorings utilized in the food industry (Barnes et al., 2012) such as tartrazine and sunset yellow, artificial colorings that can trigger allergic reactions.

In Brazil, turmeric is usually used in powder or as an essential oil (Peron et al., 2012). It is utilized not only in the food industry, but also in the pharmaceutical industry. It is recommended by the Brazilian Public Health System (SUS) as a medicinal plant and is included in National List of Medicinal Plants of Interest to SUS (RENISUS), which had 71 species of medicinal plants in research studies in 2017.

C. longa L. is a source of carbohydrates (60 to 70%), protein (6- 8%), fat (5-10%), fiber (2-7%) and essential oil and resin (5%), besides various phytochemicals (Trujillo et al., 2013). *C. longa* essential oil is rich in oxygenated sesquiterpenes, responsible for the plant aromatic characteristic (spicy), curcuminoid compounds, such as curcumin,

desmetoxycurcumin and bisdesmetoxycurcumin, responsible for rhizome pigmentation (reddish yellow phenolic pigment), curcumin as the main active substance (60 -76%), besides other compounds such as carbinol, resin, starch, polysaccharides (A, B, C and D), potassium salts, sugars, among others (Grandi, 2014).

Tumeric is mainly cultivated in tropical and subtropical regions, and India is its largest producer, consumer and exporter (Berni et al., 2014). Because it develops in moist clayey soil, this species adapts well to most tropical countries (Alonso, 1998). Its growth requires moist hot climate, temperatures ranging from 20 to 30ºC and a great amount of water availability in the soil (Priyadarsini, 2014). Despite presenting the appropriate soil and weather conditions for turmeric cultivation, Brazil still does not explore its production potential of turmeric when compared to great producers such as India, China and Indonesia, making the importation of this culture necessary (Peron et al., 2012).

In Brazil, the states of São Paulo, Goiás and Minas Gerais are the main tumeric producers, and the city of Mara Rosa, GO, is consider the saffron capital. Moreover, in 2003, Cooperaçafrão - Cooperativa de Produtores de Açafrão (Cooperative of Saffron Producers) was founded there by producers that had received theoretical support for the cultivation and commercialization of this culture, a tool for the development of the rural areas. In 2016, the Cooperative already had 72 members and 250 producers, who changed the manual management for technology, expanding the production and commercialization of in natura or dried saffron rhizome and producing approximately from 800 to 1,000 tons of dehydrated saffron yearly (Cooperaçafrão, 2017).

The soil and weather conditions as well as the species genetic diversity can alter plant secondary metabolism, which results in a variety of chemotypes (Castro et al., 2002). Besides the number of compounds, the presence of chemotypes within the same species may influence the biological actions of essential oils (Cunha et al., 2012). For example, the main compounds of *C. longa* essential oil are the sesquiterpenes ar-turmerone, α-turmerone and ß-turmerone, followed by α-santalene and ar-curcumin; however, they can differ from one plant to the other (Singh et al., 2010).

Due to the fact that the chemical compounds can present variations among the accesses of the same species cultivated in different locations, this study aimed at extracting and identifying the chemical compounds found in *C. longa* essential oil from different locations of Brazil as well as at comparing the chemical profile of the essential oil.

Results

Identification of the essential oil chemical composition

The accesses presented a total of 58 compounds (Table 1) that were distributed differently among the evaluated samples. The access that presented the greatest number of compounds was Perobal-PR (52 compounds) followed by Campo Grande/Indígena-MS (51 compounds), Campo Grande-MS (49 compounds), Mara Rosa-GO (34 compounds), Holambra-SP (26 compounds) and Santa Tereza do Oeste-PR (9 compounds). The predominant chemical class in all accesses was oxygenated sesquiterpenes (Table 1 and Fig 3), followed by hydrocarbon sesquiterpenes, mainly in the accesses in Holambra-SP (43.25%).

Agrupamento dos acessos conforme composição química do OE Grouping of accesses according to the EO chemical compositiion

The PCA indicated the formation of three distinct groups:

Group I – exclusively formed by the access in Santa Tereza do Oeste-PR, where the predominance of the compounds α-costol and α-phellandrene was observed.

Group II – formed by the access in Holambra-SP, which stands out from the other due to the greater amount of the compounds Curlone, Zingiberene, β-sesquiphellandrene, Humulene epoxide II and cis-α-trans-bergamotol, that is, it the presence of these main compounds that explains the formation/separation of this exclusive group.

Group III- formed by the accesses in Campo Grande/Indígena-MS, Mara Rosa-GO, Campo Grande-MS and Perobal-PR, it had Ar-turmerone as the main compound, which presented the occurrence percentage of approximately 40% in all accesses that were closely grouped (Table 1). Through hierarchical grouping (Fig 4), it can be observed that the accesses formed three distinct groups, and when compared to Fig 2 and Table 1, the groups were divided into: Group I, formed by the access in Holambra-SP, which was the most different when compared to the accesses of the other groups. Group II, formed by 4 accesses, Mara Rosa-GO, Perobal-PR, Campo Grande-MS and Grande/Indígena-MS and, regarding the main chemical constitution of *C. longa* essential oil, Perobal-PR and Grande/Indígena-MS were the most similar accesses. Group III, formed by the access in Santa Tereza do Oeste-PR, showed greater chemical similarity to Group II than Group I. Therefore, assessing both grouping methods, it could be observed that the accesses remained separate forming three distinct groups, two exclusive ones and one containing four out of six analyzed access, which suggests that there is the occurrence of chemotypes in *C. longa* essential oil from different Brazilian regions.

Identificação dos quimiotipos Identification of chemotypes

Chemotype I is represented by α-phellandrene and α-costol and was obtained from the essential oil of rhizomes harvested in the city of Santa Tereza do Oeste-PR, in the metropolitan area of Cascavel, western region of Paraná state. Chemotype II, composed by Curlone, Zingiberene, β-sesquiphellandrene, Humulene epoxide II and cis-α-trans-bergamotol, from rhizomes from the access in Holambra, a city in São Paulo state known as the greatest production center of flowers and ornamental plants in Latin America. Chemotype III, formed by Ar-turmerone, represents the remaining accesses including the ones in Mara Rosa-GO, Perobal-PR, Campo Grande-MS and Grande/Indígena-MS; the city of Mara-Rosa-GO is the largest producer of *C. longa* in Brazil.

Discussion

The city of Mara Rosa-GO, considered the capital of turmeric, is responsible for 90% of the national production. This species was introduced there by migrants in the 1940s and currently there are more than 300 producers working in family agriculture (Bartholo et al., 2005). This fact suggests that there is a genetic correlation of the access in Mara Rosa-GO with the other accesses that are in the same group through the chemical similarities that can be explained by the flow and/or exchange of rhizomes by producers from different areas of the country.

Table 1. Chemical composition of essential oils from *C. longa* rhyzomes obtained from 6 accesses.

Peak		Compound	RI							
				Santa Tereza do Oeste-PR	Mara Rosa- GO	Holambra-SP	Campo Grande-MS	Campo Grande/ Indigena-MS	Perobal-PR	Identification Methods
1.	3	*α*-thujene	929				0.02	0.03	0.02	a,b,c
2.	4	*α*-pinene	935	t	0.22		0.21	0.40	0.27	a,b,c
3.	5	*α*-fenchene	949				0.01			a,b,c
4.	6	Camphene	950					0.03	0.02	a,b,c
5.	7	Sabinene	974		0.03		0.03	0.10	0.04	a,b,c
6.	8	*β*-pinene	977		0.02	0.16	0.02		0.03	a,b,c
7.	9	n.i	983				0.01		0.02	a,b,c
8.	10	Myrcene	991	t	0.21		0.24	0.34	0.24	a,b,c
9.	11	*α*-phellandrene	1007	14.22	5.17	0.09	5.38	6.64	4.94	a,b,c
10.	12	*δ*-3-carene	1011	t	0.12		0.13	0.18	0.13	a,b,c
11.	13	*α*-Terpinene	1017	t	0.16		0.17	0.22	0.18	a,b,c
12.	14	*m*-cymene	1021					0.01		a,b,c
13.	15	*o*-cymene	1026		0.73		0.85	1.25	0.68	a,b,c
14.	16	Limonene	1029	t	0.44	0.04				a,b
15.	17	1,8-cineole	1032	4.19	1.66	0.31	2.45	3.00	2.34	a,b
16.	18	*cis-β*-Ocimene	1051				0.01		0.01	a,b
17.	19	*γ*-terpinene	1060		0.31		0.33	0.46	0.33	a,b
18.	20	*α*-terpinene	1088	3.43	1.11	0.85	1.26	1.49	1.39	a,b
19.	21	Linalool	1099				0.01	0.03	0.02	a,b
20.	22	*cis*-verbenol	1103				0.02	0.03		a,b
21.	23	*cis-p*-menth-2-ene-1-ol	1118				0.03	0.05	0.02	a,b,c
22.	24	*trans*-verbenol	1135				0.01	0.01	0.01	a,b,c
23.	25	*cis-β*-terpineol	1140					0.01	0.01	a,b,c
24.	26	Camphor	1148				0.04	0.07	0.02	a,b,c
25.	28	*trans-β*-terpineol	1165				0.06	0.05	0.03	a,b,c
26.	29	Terpinel-4-ol	1178	t	0.04		0.07	0.11	0.09	a,b,c
27.	30	*p*-cymen-8-ol	1185				0.02	0.03		a,b,c
28.	31	*α*-terpineol	1188	t	0.11		0.15	0.18	0.13	a,b,c
29.	32	Verbenone	1201					0.03	T	a,b,c
30.	33	Piperitone	1236					0.07	0.01	a,b,c
31.	34	Thymol	1295		0.07		0.08	0.07	0.07	a,b,c
32.	35	*δ*-elemene	1330			0.17		0.09	0.04	a,b,c
33.	36	*α*-ylangene	1375				0.06	0.04	0.07	a,b
34.	37	*β*-elemene	1391			0.92	0.08	0.04	0.03	a,b
35.	38	*β*-caryophyllene	1406	t	0.44	0.64	0.43	0.81	0.51	a,b
36.	39	*β*-copaene	1425					0.02	0.03	a,b
37.	40	*trans-α*-bergamotene	1434			1.18	0.10	0.21	0.21	a,b
38.	41	*α*-humulene	1446	t	0.18		0.07	0.17		a,b
39.	42	Dehydro aromadendrene	1458						0.17	a,b
40.	43	*trans-β*-fanesene	1458	t	0.24	0.58	0.21	0.28	0.09	a,b
41.	44	*ar*-curcumene	1477	2.54	1.14	2.20	0.85	1.49	1.02	a,b,c
42.	45	*α*-zingiberene	1494	10.46	3.36	23.00	2.76	3.96	3.18	a,b,c
43.	46	*β*-bisabolene	1504	t	0.44	2.57	0.35	0.77	0.62	a,b,c
44.	47	*β*-curcumene	1511		0.16	0.08	0.20		0.05	a,b,c
45.	48	*β*-Sesquiphellandrene	1523	7.07	2.66	11.81	2.12	3.22	2.49	a,b,c
46.	49	*α*-copaen-11-ol	1532	t	0.31	0.38	0.27	0.66	0.33	a,b,c
47.	50	*cis*-sesquisabinene hydrate	1555	t	0.63	0.65	0.71	0.89	0.76	a,b,c
48.	51	*trans*-sesquisabinene hydrate	1582	t	1.82	1.23	1.98	2.23	2.05	a,b,c
49.	52	Humulene epoxide II	1607	t	5.59	11.06	5.83	5.78	6.29	a,b,c
50.	53	*α*-acorenol	1634		3.83	2.42	4.87	4.21	4.82	a,b,c
51.	55	*ar*-turmerone	1681	14.44	40.20	25.01	38.21	35.61	38.39	a,b,c
52.	56	8-cedren-13-ol	1683		5.99	0.05	5.20	5.34	4.65	a,b,c
53.	57	*cis-α-trans*-bergamotol	1691			6.10	0.72	0.51	0.84	a,b
54.	58	Curlone	1708	3.56	16.87	5.37	15.85	13.31	15.58	a,b
55.	59	*cis-β*-santalol	1719		0.71		1.56	1.06	0.99	a,b

56.	60	*trans*-*β*-santalol	1747		2.90	1.97	3.34	1.88	3.14	a,b
57.	61	*α*-costol	1780	40.09	2.13	1.16	1.94	1.91	1.71	a,b
58.	62	*trans*-*β*-santalol acetate	1817				0.68	0.62	0.89	a,b
Total identified compounds				100.00	100.00	100.00	99.99	100.00	99.98	a,b
Hydrocarbon Monoterpenes				17.65	8.52	1.14	8.66	11.15	8.28	
Oxygen Monoterpenes				4.19	1.88	0.31	2.94	3.74	2.75	
Hydrocarbon Sesquiterpenes				20.07	8.62	43.15	7.23	11.10	8.51	
Oxygen Sesquiterpenes				58.09	80.98	55.40	80.48	73.39	79.55	
Others				0.00	0	0.00	0.68	0.62	0.89	

[a]Compounds listed in elution order in HP-5MS UI column; [b]**RI =** identification based on the calculated retention index (RI) utilizing a standard homologous series of *n*-alkanes C_7-C_{28} in Agilent HP-5MS UI column; [c]**RI** theoretical, identification based on the comparison of mass spectra found in NIST 11.0 libraries (Adams, 2017); Relative area (%): percentage of the area occupied by the compounds in the chromatogram; n.i. = non-identified; (-) not found; *t* = trace. Source: Authors.

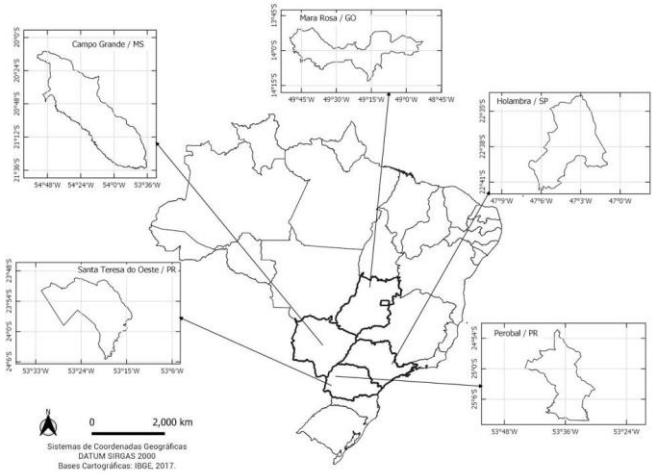

Fig 1. Detailed map of the regions where *C. longa* accesses were collected from.

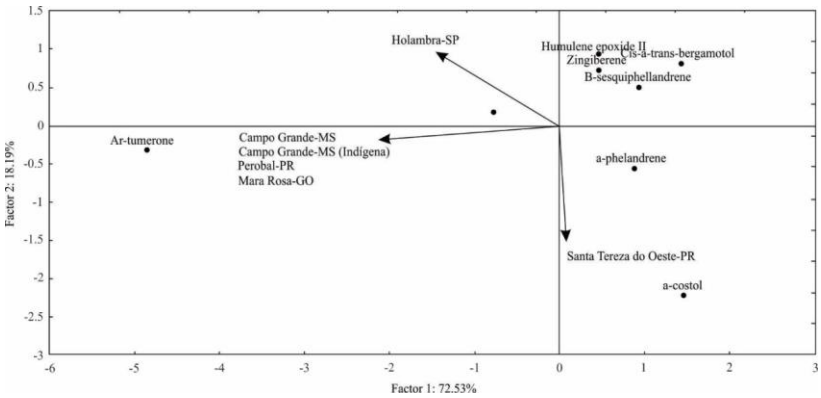

Fig 2. Biplot of PCA scores and loading for the GC-MS representing the projection of major chemical compounds of the essential oil from *C. longa* rhizomes obtained from 6 different accesses.

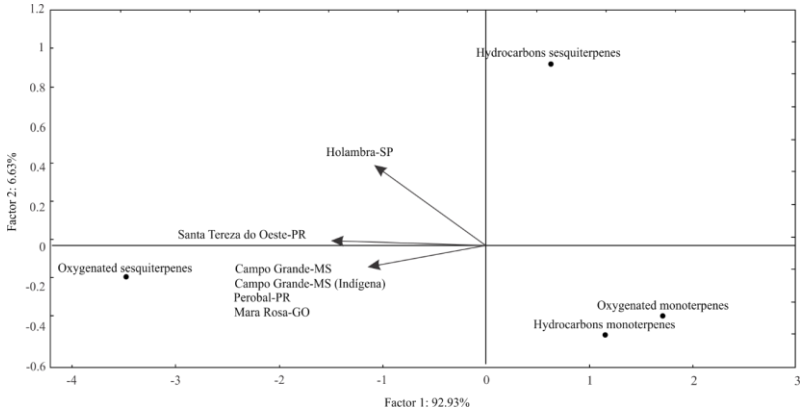

Fig. 3. Biplot of PCA and loadings for the GC-MS representing the projection of chemical classes of the essential oil from *C. longa* rhizomes obtained from 6 different accesses.

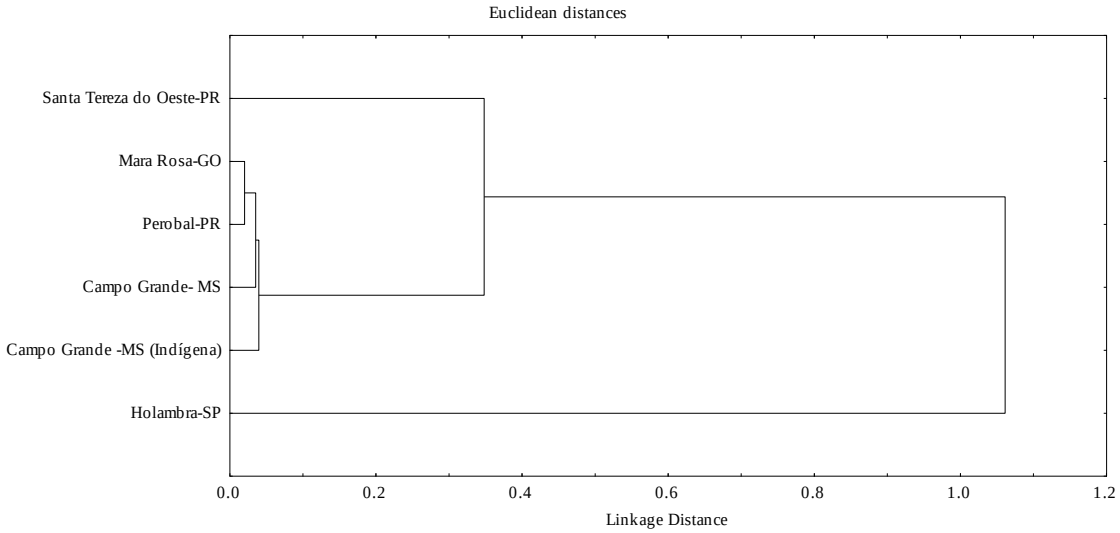

Fig 4. Hierarchic grouping (cluster) of major chemical compounds of essential oil from *C. longa* rhizomes. obtained from 6 different accesses.

Chatterjee et al. (2000) stated that much attention has been given to the chemical composition of turmeric essential oil, and the major identified compounds reported in the literature include α-phellandrene, 1,8-cineol, Zingiberene, Ar-curcumin, Turmerone, Ar-turmerone, β-sesquiphelandrene and Curlone. The compounds α-phellandrene, Zingiberene, Ar-turmerone, β-sesquiphelandrene and Curlone were also found in this study as major ones. (Majolo et al., 2014) identified Ar-turmerone, α-turmerone and 1,8-cineol in C. longa essential oil from the city of Petrolina-PE, confirming again the presence of Ar-turmerone, the major compound of the accesses in Campo Grande/Indígena-MS, Mara Rosa-GO, Campo Grande-MS and Perobal-PR.

Similarly, (Kutti Gounder and Lingamallu, 2012) verified the presence of Ar-turmerone as a major compound in C. longa oil of genotypes from Embrapa Amazônia Ocidental located in the city of Manaus/AM. (Singh et al., 2010) reported the main presence of Ar-turmerone and Curlone and associated the presence of these compounds to the excellent activity of *C. longa* essential oil against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida albicans* and *Aspergilus niger*.

However, differently from the results found in this study, (Chane-Ming et al., 2002), in a study with *C. longa* from an island in France, reported Terpinolene as the major compound, followed by 1,8-cineol and α-terpinene. On the other hand, the results by (Anant Kumar et al., 2018) pointed out Terpinolene and α-phellandrene as the major compounds of *C. longa* from the city of Tangará da Serra-MT, which were also found in the accesses in Santa Tereza do Oeste-PR, where α-phellandrene was one of the major compounds. This explains why the production of plant essential oils is, mostly, determined genetically, but it may be influenced by the environment and even if representing the same species, may present different chemical profiles (Souza, 2007).

Oguntimein et al. (1990) investigated the compounds of *C. longa* leaf essential oil from Belo Horizonte-MG, which made evident the predominant presence of monoterpenes and α-phellandrene as the major chemical compound. However, when evaluating the essential oil from rhizomes, the major compounds were Turmerone and Ar-turmerone. Turmerone and α-phellandrene were the major compounds of the access in Santa Tereza do Oeste-PR, which explains the isolation of this group in relation to the other assessed accesses; the essential oil from rhizomes was evaluated in this study.

Regarding the classes of identified chemical compounds, the results of this study corroborate the data by Oguntimein et al. (1990), who reported the sesquiterpenes Turmerone and Ar-turmerone as the major compounds of *C. longa* L rhizome essential oil. This class is found in numerous plants attracting pollinators or also protecting them against insects (Koo and Gang, 2012), whereas sesquiterpenes are the compounds that are responsible for the plant aromatic characteristic (Grandi, 2014).

In the accesses in Holambra-SP and Santa Tereza do Oeste-PR, the predominant class was hydrocarbon sesquiterpenes which are similar findings by Oguntimein et al. (1990) and the studies by Zhou et al. (2011), when investigating the compounds of *C. longa* essential oil. The oil presented, predominantly, sesquiterpenes, and the main compounds α-phellandrene and terpinolene.

Sesquiterpenes are basic volatile compounds of aromatic essential oils and the major compounds of resins belonging to a diverse group of chemical compounds, vegetal species and under varied concentrations (Pinto et al., 2015).

Sesquiterpenes are of great medical interest due to their cardiovascular, anthelmintic, antibiotic and anti-inflammatory properties, besides their antimicrobial, sedative, antidepressant activity, and presenting fumigating, repellent and insecticide action (Santos et al., 2011).

The Cluster grouping made evident that the synergism among the substances and the relative proportion of the compounds can also attribute distinct activities to the same species when produced under the same conditions and location, as observed in Figure 4.

According to Morais (2009), the chemical composition of essential oils extracted from the same plant part can vary significantly. Borsato et al. (2007) stated that genetic factors are among the ones that influence the quality of essential oil production because they can cause significant changes in the metabolic pathways, resulting in the biosynthesis of different compounds.

Oliveira et al. (2012) reported that factors such as geographical origin, cultivation management, cultivation

area, harvesting time, rhizome state (fresh or dried), drying process and the experimental and analytical conditions contribute to the variation of the essential oil content and chemical composition. Scartezzini and Speroni (2000) stated that the matrix plant, soil type, climate, fertilization, water availability and storage time also contribute to this variation. In this study, the soil and weather conditions as well as the rhizome harvesting time, drying process, and extraction method were all the same for all evaluated accesses. Therefore, the intra-specific genetic variations may have caused the active principle alteration as suggested by Apel et al. (2006). Thus, further research studies on the genetic base of this species should be carried out to refute or corroborate such hypotheses on the correlation between the chemical diversity and *C. longa* genetics.

Materials and Methods

Plant material collection and cultivation

Six *C. longa* accesses from different regions of Brazil were evaluated: Perobal-PR, Santa Tereza do Oeste-PR, Campo Grande/Indígena-MS, Campo Grande-MS, Mara Rosa-GO and Holambra-SP (Figure 1). The experiment was carried out in a greenhouse at Campus III of Paranaense University (UNIPAR), in the city of Umuarama – PR, located at the geographical coordinates 23º45' south latitude and 53º19' west longitude, and altitude of 430 m. The greenhouse had a 0.10 mm- thick transparent low-density polyethylene (LDP) covering in arch shape and 9 m of length and 13 m of width.

The rhizome planting was done in 12-L pots at 3:1 ratio (3 parts of soil and 1 part of commercial substrate), in 4.0 cm deep holes dug 0.20 cm from each other; the spacing between the rows was 0.40 m. In each pot, three rhizomes from the same access were planted, one per hole. Irrigation was done as required by the cultivation. The vases were kept in the greenhouse for approximately nine months until the aerial part of the plant was dried, indicating the ideal period for rhizome harvesting. All the accesses were cultivated under the same environmental conditions.

Essential oil extraction

After having been harvested, the rhizomes were cleaned and slices, place on a counter and kept at room temperature for drying for around 15 days. For the essential oil extraction, the rhizomes were weighed and grounded with deionized water and kept in a large-bottom flask for 5 hours. The essential oil was withdrawn with anhydrous sodium sulfate (Na_2SO_4) and stored at 10ºC.

Chemical composition of the essential oil

The chemical composition analysis was done in a gas chromatographer (Agilent 7890 B) coupled to a mass spectrometer (Agilent 5977 A) equipped with an Agilent HP-5MS UI capillary column (30m x 0.250mm x 0.25mμ) under the following conditions: injector temperature of 260°C, injection volume of 2mL at a 1:2 ratio (split mode), column initial temperature of 50°C with gradual increase until 280°C and a ramp of 5°C/min. The carrier gas flow (helium) was fixed at 1 mL/min. The temperatures of the transfer line, ionization source and quadrupole were 280, 230 e 150°C, respectively. The mass spectra were obtained in the 40-500 (m/z) interval provided through the scanning mode with the solvent permanence time of 3 min. The compounds were identified based on the comparison of their retention indexes (RI) obtained from a series of n-alkanes (C8 – C30). The obtained EI-mass spectra were compared to the ones in Wiley Spectrum Library275L and according to the ones in the literature (Adams, 2017).

Statistical analysis

The collected data were submitted to multivariate exploratory analysis through the analysis of principal components (APC), which allowed the joint evaluation of the main chemical compounds and the chemical class of all compounds found in the essential oil from *C. longa* accesses. The result of the analyses was presented in a graph (BIPLOT), helping the characterization of the analyzed group variables (Moita Neto and Moita, 1998).

For each essential oil sample, the chemical compounds and their respective chemical classes as well as their relative area (%) were identified (Table 1). These data were transformed in latent orthogonal variables named min components that are linear combinations of the original linear variables created with self-values of the data covariance matrix (Hair et al., 2009).

Kaiser's criterion was utilized to select the main components. The analysis was carried out in two ways: the former containing only data refereeing to the chemical composition of the main compounds, using as inclusion and exclusion criterion only the ones whose area was larger than 14%; and for the latter, the data were analyzed by grouping the chemical classes that belonged to these compounds. Both analyses were performed in Statistica 7 Program (Statsoft, 2004).

Conclusion

Within the evaluated accesses, the formation of three distinct groups based on the analysis of *C. longa* essential oil chemical composition was observed, suggesting that there is the formation of chemotypes. This allows to conclude that, even if they are accesses of a same species and under the same cultivation conditions, there is chemical variability of *C. longa* essential oil.

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