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Full Length Research Paper

Chemical composition of essential oils from the stem barks of *Croton conduplicatus* (Euphorbiaceae) native to the Caatinga biome

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Croton conduplicatus **is a species popularly known in the Brazilian Caatinga (semi-arid vegetation) as "quebra faca". Essential oils from the stem barks of *C. conduplicatus* were obtained by hydrodistillation after 2, 3 and 4 h of extraction with a very high percentage (95.93, 96.69 and 98.45%, respectively) of identified total components present in crude essential oils. Analyses were made by gas chromatography/mass spectrometry (GC/MS). The most abundant constituents were α-pinene, β-pinene, camphor and (*E*)-caryophyllene. The occurrence of α-pinene and β-pinene has been reported in essential oils of several other species of *Croton*, indicating that this species is typically of the Euphorbiaceae family.**

Key words: *Croton conduplicatus*, essential oil, volatile constituents, medicinal plants, Caatinga.

INTRODUCTION

Croton (Euphorbiaceae) is one of the largest genera of flowering plants, with nearly 1300 species of herbs, shrubs and trees that are ecologically prominent and often important elements of secondary vegetation in the tropics and subtropics worldwide (Simionatto et al., 2007).

Some species of the genus *Croton*, such as *Croton cajucara*, *Croton zambesicus*, *Croton nepetaefolius* and *Croton celtidifolius*, have been described as medicinal plants with their biological activities assessed. Amongst such plants studied to date, many have been revealed to display multiple biological activities, such as anti-inflammatory, antioxidant, antinociceptive, anticonvulsant and anxiolytic activities (Zhao et al., 2012).

Plants belonging to the genus *Croton* are well known for producing a variety of diterpenoids including pimarane, kaurane, labdane, cembrane, cleisthantane, and clerodane diterpenoids, with a wide range of

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Table 1. Chemical composition of essential oils of stem bark of *Croton conduplicatus* subjected to hydrodistillation for 2, 3 and 4 h of extraction.

Order	Compounds	RI*	GC/MS (%)		
			After 2 h	After 3 h	After 4 h
1	Tricyclene	922	0.39	0.78	0.50
2	α-Thujene	924	0.75	0.55	0.13
3	α-Pinene	932	32.87	35.35	25.84
4	Camphene	948	4.01	8.01	5.66
5	Sabinene	971	0.06	---	---
6	β-Pinene	977	13.56	16.77	7.79
7	Myrcene	988	0.72	0.50	0.24
8	*p*-Cymene	1024	0.72	0.56	0.44
9	Limonene	1028	1.24	1.40	0.72
10	1,8-Cineole	1031	1.46	0.29	0.54
11	γ-Terpinene	1056	0.15	0.21	0.14
12	*cis*-Linalool oxide	1069	0.13	---	---
13	*trans*-Linalool oxide	1086	0.56	0.81	0.36
14	Linalool	1100	2.18	1.24	0.86
15	NI	1104	0.24	---	---
16	*trans*-Pinocarveol	1140	---	0.31	---
17	Camphor	1146	7.30	9.32	6.37
18	Camphene hydrate	1154	---	0.19	0.15
19	Borneol	1171	0.33	0.33	0.64
20	Terpinen-4-ol	1179	0.87	0.52	0.29
21	α-Terpineol	1194	1.40	0.87	0.70
22	Thymol methyl ether	1228	0.70	---	0.49
23	Cyclosativene	1365	0.66	0.63	0.46
24	α-Copaene	1373	0.62	1.14	0.68
25	β-Elemene	1387	0.30	0.16	0.25
26	α-Gurjunene	1399	---	---	0.28
27	(*E*)-Caryophyllene	1416	7.80	4.66	5.07
28	β-Cubebene	1426	0.64	---	0.34
29	NI	1445	---	---	0.33
30	α-Humulene	1452	1.47	0.84	1.18
31	NI	1464	---	---	0.51
32	γ-Muurolene	1472	2.08	0.19	2.76
33	Germacrene D	1477	0.36	---	0.80
34	α-Selinene	1492	---	---	0.37
35	α-Muurolene	1496	3.66	3.21	1.79
36	β-Bisabolene	1506	---	0.30	0.27
37	δ-Amorphene	1509	---	---	0.38
38	γ-Cadinene	1509	0.23	---	---
39	NI	1511	---	---	0.44
40	δ-Cadinene	1515	0.31	0.26	1.78
41	NI	1538	0.18	---	---
42	Elemol	1545	0.30	---	---
43	Hedycariol	1545	---	---	0.57
44	Germacrene B	1554	---	0.20	0.32
45	Caryophyllene oxide	1578	6.63	3.88	6.91
46	Viridiflorol	1585	---	---	0.22
47	Guaiol	1593	0.66	0.41	0.83
48	Globulol	1600	---	---	1.12
49	Humulene epoxide II	1605	0.84	0.50	1.16

Table 1. Cont'd.

50	NI	1622	2.16	1.70	---
51	Aristolene	1629	---	1.00	1.32
52	NI	1633	0.39	0.48	---
53	Hinesol	1636	---	0.76	0.76
54	NI	1652	0.65	0.63	---
55	NI	1667	0.45	0.50	---
Total		-	95.93	96.69	98.45

*RI: Retention indices on DB-5MS column (relative to *n*-alkanes); NI: not identified compound; (---): Not detected.

biological activities (Pudhom et al., 2007). On the other hand, essential oils are other important class of secondary metabolites in this genus. Recently, Salatino et al. (2007) reported the study of the essential oils of about thirty species of *Croton*. The results indicated that some of these oils are rich in terpenoids and phenylpropanoids, and others are rich only in terpenoids (Salatino et al., 2007).

Despite of the large array of data on other *Croton* species, the knowledge about *Croton conduplicatus* is scarce. This species is popularly known in the Brazilian Caatinga as "quebra faca". Decoction of its leaves and stem barks are used in folk medicine to treat influenza, headache, indigestion, stomach problems and stomachache (Cartaxo et al., 2010). To the best of our knowledge, no phytochemical and pharmacological studies have previously been reported on this species.

This paper presents for the first time the chemical composition of *C. conduplicatus* stem barks essential oils by gas chromatography/mass spectrometry (GC/MS).

MATERIALS AND METHODS

Plant

Stem barks of *C. conduplicatus* Kunth. were collected from a single individual in September 2012 in Petrolina (Coordinates: S 09°03'54"; W 40°19'12"), State of Pernambuco, Brazil. A voucher specimen (HTSA2421) was deposited at the Herbário do Trópico Semiárido (HTSA) of the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA). Considering that the plant is a shrub, the stem barks were cut close to the ground.

Extraction of essential oils

The fresh stem barks (100 g) were cut into pieces, and subjected to hydrodistillation for 2, 3 and 4 h in a modified Clevenger-type apparatus. The oils were dried over anhydrous sodium sulfate. The essential oils obtained have yellow color and characteristic odor. The oils were stored in a refrigerator until the analysis by GC/MS.

Analysis of essential oils

The substances present in the essential oil of *C. conduplicatus* were investigated on a Shimadzu QP-2010 gas chromatograph interfaced to a mass spectrometer (GC/MS). The following conditions were used: DB-5MS column Agilent Technologies (30 m × 0.25 mm × 0.25 μm); helium (99.999%) carrier gas at a constant flow of 1.1 ml/min; 1.0 μl injection volume; injector split ratio of 1:10; injector temperature 250°C; electron impact mode at 70 eV; ion-source temperature 280°C and transfer line temperature 260°C. The oven temperature was programmed from 60°C, with an increase of 3°C min^{-1} to 240°C.

A mixture of linear hydrocarbons (C_9H_{20}–$C_{21}H_{40}$) was injected under the same experimental conditions as samples, and identification of the constituents was performed by comparing the spectra obtained with those of the equipment database (Wiley 7 lib and Nist 08 lib) and by using the Kovats Index, each constituent was calculated as previously described (Adams, 1995; Van den Dool and Kratz, 1963). The data were acquired and processed with a PC with Shimadzu GC/MS Solution software.

RESULTS AND DISCUSSION

In every extraction, 100 g of *C. conduplicatus* stem barks were used and the crude oils yield was found to be 0.90, 0.97 and 0.97 ml, for 2, 3 and 4 h of extraction, respectively. The CG/MS analysis led to the identification of 95.93, 96.69 and 98.45% of the total components present in crude essential oils.

The chemical constituents of the essential oil of *C. conduplicatus* were identified by comparing their mass spectral data with reference spectra in the computer library. The identified compounds are as shown in Table 1 according to their retention indexes.

The main compounds found in the oil of the stem barks after 2, 3 and 4 h of extraction were α-pinene (32.87, 35.35 and 25.84%, respectively), β-pinene (13.56, 16.77 and 7.79%, respectively), camphor (7.30, 9.32 and 6.37%, respectively) and (*E*)-caryophyllene (7.80, 4.66 and 5.07%, respectively). Variation in extraction time was performed to verify their influence on the yield and the chemical composition of the essential oil. Depending on the compound of interest, the time of extraction can be adjusted.

In light of these chemical evidences, some authors purpose to consider that the co-occurrence of α and β-pinene might be a characteristic of the genus *Croton*, however, in the light of a larger number thus far studied, taxa, β-caryophyllene and linalool seem to be equally a frequent major constituents of many *Croton* spp. (Radulovic et al., 2006).

Particular relevance should also be given to the presence of minor, but not negligible compounds detected in our samples as caryophyllene oxide, camphene and α-muurolene. The relatively high content of camphene in the stem oil differentiates *Croton decaryi* from the other members of the genus *Croton* since there are no published data on a *Croton* spp. containing this monoterpene hydrocarbon as one of the major constituents (Radulovic et al., 2006). Thus, camphene could be considered as chemotaxonomic marker for *C. decaryi*.

Conclusion

C. conduplicatus has been examined for the first time for the essential oil obtained by hydrodistillation of fresh stem barks. GC/MS has been provided in order to chemically characterize the essential oil, evidencing a monoterpene prevalence. In comparison to the others essential oils from *Croton* spp., the oil of this species shows constituents that are present in other species of this genus.

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Conflict of interest

Authors declare that there are no conflicts of interest.

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