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Chemical Compositions of the Essential Oils and Absolutes of the Flowers of *Bombax costatum* Pellgr. Et Vuillet (Bombacaceae) from Mali

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ABSTRACT

The chemical compositions of essential oils and absolutes of the flowers of Bombax costatum harvested in N'Tonimba, N'Tabacoro and Sanankoroba (Mali) were determined by gas chromatography (GC) and gas chromatography coupled with mass spectrometry (GC/MS). Forty-two components were identified in the essential oils from which the majority are linear alkanes such as docosane (9.28 to 17.34%), heneicosane (9.18 to 17.28%), tricosane (7.06 to 13.09%), tetracosane (3.62 to 7.62%). Forty-five compounds in which the absolute. The majoritary components are hexadecanoic acid (23.04 to 25.38%), dehydroaromadendrene (7.11 to 12.10%) and ethyl oleate (7.94 to 10.36 %). The chemical compositions of essential oils and the absolute are different.

Keywords: Essential oils, Absolutes, Gas chromatography, Mass spectrometry, Chemical components

INTRODUCTION

Bombax costatum is a tree of 12 to 20 m high but not exceeding 5 to 6 m in Sahelian areas or arid soils, with a diameter of 30 to 60 cm. Compound and palmate leaves with 5 to 7 folioles. Solitary bright red flowers, sometimes yellow or orange; usually 5-6 cm long. It is found together with the population of red flowers and orange flowers ones [1,2]. The flowering occurs in the dry season when the plant is completely defoliated, from November to February [1] It is a nectariferous plant [3,4].

It is a plant which grows in woody savannas and from Sahelo-Sudanese to Guinean scattered forests, on many types of soil, but sometimes on lateritic or rocky stations from Senegal to Cameroon [1].

The tree produces light wood used in the manufacture of matches. The petals of flowers are consumed by animals and are also used in the preparation of the sauce [4]. The plant produces kapok collected for stuffing cushions [5]. In Mali the bark powder is used to treat wounds, a decoction of the root or stem bark is used in the treatment of inflammatory diseases [6]. In Guinea decoctions of roots and leaves are recommended in the treatment of infections including sexually transmitted diseases [7]. In Burkina Faso a decoction of the stem bark is recommended to treat anemia and the macerated to treat mental disorders [8]. The bark is emollient; it promotes childbirth and is used in the treatment of diarrhea, bruising, gonorrhea. The root is used in the treatment of epileptic fit. The decoction of the bark associated with the root is used to treat dysmenorrhea. The fruits are used in the preparation of drinks [3].

During our investigations, we did not encounter any studies on essential oils for this plant. Thus, we extracted with hexane in order to carry out a comparative study of the chemical composition of the obtained product with that of essential oils.

The few completed work focused on non-volatile constituents.

So, Cook et al. [9], Glew et al. [10] during their studies were able to identify in fruits harvested in Niger and Burkina Faso, fatty acids, proteins and mineral elements (calcium, copper, iron, potassium, magnesium, manganese, sodium, zinc, molybdenum). The antioxidant activity of aqueous extracts of the fruit harvested in Niger has been proven [11,12].

MATERIALS AND METHODS

The flowers of *Bombax costatum* were harvested in January around the apiaries of N'Tonimba, Sanankoroba and N'Tabacoro all located in Kati area, Mali.

The sample of the plant was identified and then was deposited in the herbarium of the Department of Traditional Medicine (DMT) under the number 1515.

We first made a conventional extraction of essential oil by stripping sample in the water vapor with was a vapor circulation apparatus which was modified Kaiser-Lang.

Our tests involved three kilograms of flowers for each site.

Given the low flowers in volatile components, we used a thin layer (5 mL) of n-hexane to trap the essential oil. The average duration of distillation was three hours. At the end of the extraction the hexane solution was recovered by decantation, essential oil was obtained after removing the solvent by evaporation.

The hexane extraction was performed on 500 g of flowers from three sites.

After 48 h maceration in 1000 mL of n-hexane, the soaked vegetable matter was filtered and the filtrate was evaporated under reduced pressure, and at a temperature of 40°C. Then, we obtained a solid fragrant mixture: the concrete. It was treated with 50 mL of ethanol at 95° in cold (-20°C) for 24 h.

Waxes (the precipitated) were removed by filtration of this mixture. The ethanol was then evaporated to yield an extract called "hexanic" (E Hex) or absolute (Abs).

All samples of essential oil and absolute were analyzed by GC/MS. Each outgoing component of the column passes directly into the ionization field of the spectrometer. The molecule subject to electron impact was fragmented.

The GC/MS couplings were performed on a 7890 Agilent type device, coupled with an Agilent 5975 MS spectrometer equipped with a DB5 MS column (20 m × 0.18 mm, 0.18 .mu.m), the programming of the oven 50° C for 3 min, 8°/min from 50 to 320°C, 5 min at 320°C. The carrier gas was helium (1.0 mL/min); the injector and the detector were at the same temperature of 280°C. MS spectrometer operates in electron impact mode at 70 eV; the temperature of the ion source was 230°C. The injector was in split mode 1/100.

The identification of the compounds was done by comparison of their mass spectra and their Kovats index (KI) with those of Adams, NIST and Wiley databases [13-15] and the one established by LEXVA laboratory.

RESULTS AND DISCUSSION

Essential oils were extracted with a similar yield for all the sites, but remain very low with an average of 0.002%.

Forty-two components were identified in the essential oils of *Bombax costatum* flowers from Mali. The complete analysis results are summarized in Table 1.

The major constituents are linear alkanes such as docosane (9.28 to 17.34%), heneicosane (9.18 to 17.28%), tricosane (7.06 to 13.09%) and tetracosane (3.62 to 7.62%).

On the other significant components such as tetracosane (3.62 to 7.62%), hexacosane, (0.93 to 6.35%), pentacosane

Table 1: Chemical composition of essential oils of the flowers of *Bombax costatum*

RT: Retention Time; Tr: Traces; -: Absent

					Sites	
N°	**KI**	**RT**	**Compounds**	**N'Tonimba**	**N'Tabacoro**	**Sanankoroba**
1	1098	9,315	**Linalol**	**1.24**	**0.89**	**0.64**
2	1104	9,4101	Nonanal	0.46	0.25	0.34
4	1175	10,903	Terpinene-4-ol	0.31	0.46	0.39
5	1190	11,114	methylsalicylate	0.65	1.08	1.3
6	1300	13,106	Tridecane	0.21	-	-
7	1376	14,393	Alpha copaene	0.29	-	-
8	1391	14,618	Beta elemene	0.80	-	-
9	1400	14,797	Tetradecane ($C_{14}H_{30}$)	0.11	-	-
10	1421	15,121	Beta caryophyllene	**1.48**	tr	tr
11	1430	15,265	Gamma elemene	0.79	0.12	-
12	1434	15,323	(E)-Alpha-Bergamotene	**1.26**	0.27	-
13	1448	15,534	Geranylacetone	0.21	tr	-
14	1443	15,622	(Z)-beta-farnesene	0.54	0.34	-
15	1454	15,696	Alpha humulene	0.97	0.45	-
16	1480	16,097	Germacrene-D	**3.24**	0,12	-
17	1485	16,223	Beta sélinene	0.57	tr	-
18	**1500**	16,383	**Pentadecane**	**5,24**	**0.54**	**0.22**
19	1508	16,432	Alpha-Farnesene	_	0.22	0.14
20	1509	16,496	Beta-bisabolene	**1.88**	tr	-
21	1507	16,584	Gamma-cadinene	0.31	-	-
22	1520	16,661	Delta-cadinene	0.9	-	-
23	1524	16,744	Beta sesquiphellandrene	0.37	tr	-
24	1538	17,023	Selina, 3-5(11)-diene	0.19	0.15	-
25	**1552**	17,285	**Germacrene B**	**2.27**	**0.42**	**0.18**
26	1570	17,442	Benzoate de hex-3-en-1-yle (Z)	0.26	-	-
27	1581	17,63	Caryophyllene oxide	**1,31**	0,15	0.1
28	1653	18,676	Alpha-Cadinol	**1.03**	0.12	0,21
29	**1700**	19,295	**Heptadecane**	**2.42**	**0.57**	**0.39**
30	1800	20,64	Octadecane	0.45	0.61	0.56
31	1794	20,723	Octadec-1-ene	0.38	0.29	0.15
32	**1900**	21,925	**Nonadecane**	**1.75**	**2.21**	**2.64**
33	**1984**	22,676	**Hexadecanoic acid**	**1,95**	**1,46**	**0,73**
34	**2000**	23,156	**Eicosane**	**5.19**	**8.31**	**9.21**
35	**2100**	24,331	**Heneicosane**	**9.18**	**17.28**	**16.45**
36	**2200**	25,456	**Docosane**	**9.28**	**14.76**	**17.34**
37	**2300**	26,532	**Tricosane**	**7.06**	**11.78**	**13.09**
38	**2400**	27,564	**Tetracosane**	**3.62**	**7.62**	**6.75**
39	**2500**	28,559	**Pentacosane**	**2.31**	**4.27**	**3.92**
40	**2700**	30,442	**Heptacosane**	**1.93**	**6.35**	**5.82**
41	**2800**	31,332	**Octacosane**	**2.88**	**0.79**	**0.59**
42	**2900**	32,196	**Nonacosane**	**1.90**	**1.53**	**1.91**
			Total	**77.19**	**83.41**	**83.07**

(2.31 to 4.27%), pentadecane (0.22 to 5.24%), heptacosane (0.59 to 2.88%), nonadecane (1.75 to 2.64%), heptadecane (0.39 to 2.42%), octacosane (1.53 to 1.91%) and oxygenated hydrocarbons such as hexadecanoic acid (0.73 to 1.95%), and linalool (0.64 to 1.24%) were identified.

The average of absolute yield was approximately 0.014% on the three sites. Table 2 provides the complete results of the analysis of the absolute of *Bombax costatum* flowers from Mali. Forty-three compounds were identified, representing 82.66 to 94.60% of absolute. The compounds for which KI are not given were identified only by comparing their mass spectra with those databases.

Hexadecanoic acid has been the major component of absolute of the flowers of *Bombax costatum* of the three sites and its rates ranging from 23.04 to 25.38% followed by dehydroaromadendrene 7.11 to 12.10% and ethyloleate 7.94 to 10.36%

Other components less consequential such as oleic acid (0.69 to 8.35%), 1-docosene (2.36 to 7.99%), ethyl linoleate (2.16 to 7.62%), 2,2'-methylenebis [6-(1,1-dimethylethyl)]-4-methylphenol (1.65 to 6.59%), 2,2,6-trimethyl-1-(2-methylcyclobut-2-enyl) hepta-4,6-dien-3-one (4.04 to 4.26%), beta-stigmasterol (3.4 to 3.42%), acid octadeca-9,12-dienoic acid (0.61 to 3.11%), octadécan-1-ol (0.8 to 2.42%) were also identified.

Absolute yield has been seven times higher than that of essential oils. The chemical composition of these essential oils was not homogeneous in the three sites. However, the docosane with rates ranging from 9.28% to 17.34% has been the major compound in the samples of the sites of N'Tonimba and Sanankoroba. Also, the heneicosane with a rate 17.28% has been the major compound in that of N'Tabacoro. Beta-bisabolene with a rate of 1.88% in the sample of N'Tonimba, exists only in trace amounts in that of N 'Tabacoro and is absent in that of Sanankoroba; beta-caryophyllene identified in the extract of N'Tonimba with a rate of 1.48% exists in that of N'Tabacoro and Sanankoroba in the form of traces; (E) -alpha-bergamotene and germacrene D, with the rates of (1.26 to 0.27) and (3.24 to 0.12) respectively in the extracts of N'tonimba and N'Tabacoro, have not been identified in that of Sanankoroba.

Table 2: Chemical composition of absolute of the flowers of *Bombax costatum*

				Sites		
N°	KI	TR	**Compounds**	**N'Tonimba**	**N'Tabacoro**	**Sanankoroba**
1		3,5136	4-Hydroxy-4-methylpentan-2-one	0.22	0.18	-
2	-	13,9689	2-Ethylhexanoate de nonyle	0.12	tr	-
3	-	16,4523	2,4-bis(1,1-dimethylethyl)phenol	0.12	0.31	0.27
4	-	16,7838	5,6,7,7a-tetrahydro-4,4,7a-trimethyl-2(4H)-benzofuranone	-	0.1	0.17
5	-	20,0161	2,4,4-Trimethyl-1-pentyl methylphosphonofluoridate	-	0.23	0.58
6	1720	20,0812	Tetradecanoic acid	0.21	0.55	0.86
7	-	20,8532	Pentadec-1-ene	-	tr	0.12
8	-	21,9198	Hexadecan-2-one	0.10	0.15	tr
9	1927	22,219	Methylpalmitate	-	0.18	tr
10	1984	22,7246	**Hexadécanoic acid**	**23.04**	**25.38**	**24.75**
11	2173	24,677	**(Z,Z) Octadéca-9,12-dienoic acid**	**3.11**	**1.25**	**0.61**
12	2161	24,7535	**Hexadec-9-enoïc acid**	**8.35**	**3.86**	**0.69**
13	-	24,8067	**Ethyloleate**	**8.35**	**7.94**	**10.36**
14	-	24,9715	**Ethyllinoleate**	**2.16**	**4.61**	**7.62**
15	2171	25,0363	**Octadenoïc acid**	-	1.43	2.00
16	2200	25,4121	Docosane	0.68	2.54	1.37
17	-	26,2281	(Z)-9-Tricosene	0.12	0.15	0.20
18	-	27,5801	**2,2'-Methylenebis[6-(1,1-dimethylethyl)]-4-methylphenol**	**6.59**	**5.71**	**1.65**
19	-	27,7794	(E,E)-hexadeca-10,12dien-1-ylacetate	0.22	0.42	0.34
20	-	27,8489	13-Oxabicyclo[10.1.0]tridecane	0.96	0.65	0.36
21	-	28,2895	1-Heneicosylformate	-	0.76	1.17
22	-	28,4474	Alpha-(beta-D-glucopyranosyloxy) benzeneacetonitrile	0.24	0.32	-
23	-	28,8021	Di-2-ethylhexylphtalate	0.46	0.33	0.71
24	-	29,5279	(Z,Z)-2-Methyloctadeca-3,13-dienol	1.18	0.21	0.31
25	-	29,53	(Z)-Octadec-9-enal	0.68	0.52	0.82
26	-	30,2016	Heptacosene	2.31	tr	-
27	2700	30,4331	Heptacosane	0,33	0,32	0,31
28	-	31,1855	(R)-(-)-14-Methyl-8-hexadecyn-1-ol	0.44	0.51	0.42
29	-	31,9869	**1-Nonacosene**	**7.99**	**6.27**	**2.36**
30	-	32,9174	12-Hydroxy-1-nitrobicyclo[9.3.1]pentadecan-15-one	0.37	0.38	0.45
31	-	33,1176	14-Methylhexadec-8-enal	0.95	0.82	0.44
32	-	33,3582	Gamma-Tocopherol	0.62	0.57	0.36
33	-	33,6564	**Nonacosan-1-ol**	**2.42**	**1.47**	**0.8**
34	3121	33,9903	Vitamin E	0.61	0.45	0.22
35	-	35,4061	**Beta sitosterol**	**3.4**	**3.44**	**3.42**
36	-	35,7088	3,5,6,7,8,8a-hexahydro-4,8a-dimethyl-6-(1-methylethenyl)-2(1H)Naphthalenone,	0.38	0.34	0.28
37		35,8469	**Dehydroaromadendrene**	**7.11**	**9.46**	**12.10**

38	-	36,065	**2,2,6-Trimethyl-1-(2-methylcyclobut-2-enyl) hepta-4,6-dien-3-one**	**4.19**	**4.26**	**4.04**
39	_	36,9376	Ergost-25-ene-3,5,6,12-tetrol	1.23	0.98	0.87
40	_	38,2777	9-Octyleicosane	1.18	0.58	-
41	_	38,4513	1,1'-[3-(2-cyclopentylethyl)-1,5-pentandiyl] bicyclopentane	1.01	0.47	0.72
42	_	40,5483	1,2-diethycyclohexadecane	2.14	0.78	-
43	_	44,1812	**N-Cyano-N',N',N'',N''-tetramethyl-1,3,5-triazinetriamine**	**2.09**	**1.57**	**tr**
			Total	**94.60**	**99.12**	**82.66**

The oleic acid in the absolute of the flowers of *Bombax costatum* from N'Tonimba and N'Tabacoro sites is present with rates of 8.35% and 3.86% respectively. However, it has been found in a very small proportion (0.69%) in the sample of Sanankoroba.

The above results show that the main constituents of essential oils which are saturated hydrocarbons have not been detected in the absolute flowers.

The hexadecanoic acid, the majority compound of absolute with rates ranging from 23.04 to 25.38% is also present in the essential oils but in the lower proportions (0.73 to 1.95%).

Fatty acids such as oleic acid, linoleic acid; esters of fatty acids such as ethyl oleate, ethyl linoleate, and certain alcohols and ketone such as 2,2'-methylenebis [6-(1,1-dimethylethyl)]-4-methylphenol, the 2,2,6-trimethyl-1-(2-méthylcyclobut-2-enyl) hepta-4,6-dien-3-one, octadécan-1-ol and beta-stigmasterol present in the absolute as constituents characteristics have not been also identified in essential oils.

The Figure 1 and Figure 2, show the different chemical groups in essential oils and absolutes.

The analysis of the diagrams shows that alkanes, the majority chemical group of essential oils with levels ranging from 53.53% in N'Tonimba to 78.79% in Sanankoroba, are present in absolute only in very small proportions (0.99 to 2.86%). The sesquiterpenes present in the sample of N'Tonimba with a rate of 17.32% and the monoterpenes present in essential oils in small proportions are not detected in absolutes.

Similarly, fatty acids, the predominant chemical group of absolutes with levels varying from 28.91% in Sanankoroba to 34.71% in N'Tonimba are present in essential oils in small proportions. The esters of fatty acids with levels of

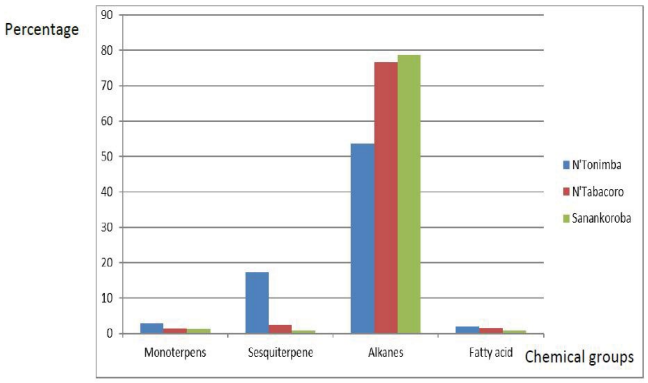

Figure 1: Histogram of majority chemical groups of essential oils

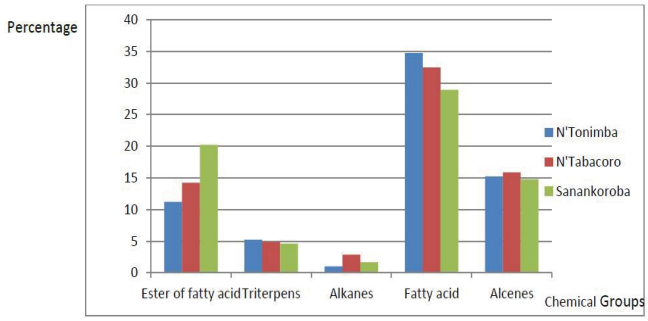

Figure 2: Histogram of majoritary chemical groups of absolutes

11.21% in N'Tonimba to 20.29% in Sanankoroba, the alkenes with about 15% in the three sites, the triterpenes with levels close to 5% in absolutes are not identified in essential oils.

We were not able to make a comparative study with some research works through scientific literature in West African's counties particularly in Mali.

Thus, this innovative work compared to research on the volatile constituents of *Bombax costatum* can be of great importance in view of the food use made of these flowers by the populations [4].

CONCLUSION

The results of this study showed that the chemical composition of volatile extracts of the flowers of *Bombax costatum* depend to the extraction mode. So, the major constituents of essential oils are alkanes that of absolutes are fatty acids and esters of fatty acids.

This work, the first on the volatile constituents of *Bombax costatum* flowers is a more for literature.

In prospect, it will be interesting to make biological tests in order to account to us for the efficacity of these extracts on certain pathogenic germs.

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