Original Research Article

Chemical composition and antioxidant activity of the essential oil of *Cardiospermum grandiflorum* Sw harvested in Kokumbo in Ivory Coast

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ABSTRACT

Aims: The objective of this work is to contribute to the valorization of medicinal and aromatic plants of the Ivorian flora. We propose to determine the chemical composition and to evaluate the antioxidant activity by spectrophotometry of the essential oil of *Cardiospermum. grandiflorum* Sw

Study design: valorization of aromatic and medicinal plants.

Methodology: The technical of steam distillation using a four-compartment stainless steel device was used to extract the essential oil from the plant matrix.
The analysis of the essential oils was carried out on a GC chromatograph (7890A, Agilent Technologies) coupled to a mass spectrometer (5975C, Agilent Technologies). The identification of the compounds was carried out by comparison of the retention indices and mass spectra obtained with those from the National Institute of Standards and Technology (NIST) database and from the literature
The antioxidant potential of the extracts was evaluated using the Blois method.

Results:
The essential oil obtained by steaming, with an aromatic odor and pale yellow color has a yield of (0.0045 ± 0.0002) %.
Analysis of the chromatogram and mass spectra obtained by GC-MS identified 24 phytocompounds representing 99.45 % of the total chemical composition.. The chemical composition of EO consists mainly of hydrocarbon sesquiterpenes (97.72 %).The major compound is γ-muurolene (46.06 %) (A) followed by β-Caryophyllene (24.35 %) (B) and γ-elemene (7.07 %).
The essential oil extract of *C. grandiflorum* exhibits low antioxidant activity compared to vitamin C. The IC_{50} value of vitamin C is 0.31 µg / mL while that of EO extract of *C grandiflorum* is 15.1 µg / mL
Conclusion: In the present study, we are interested in the valuation of *Cardiospermum grandiflorum* an aromatic plant used in traditional Ivorian medicine. The yields of essential oil is low. (24) phytocompounds were identified there. The essential oil has less antioxidant activity than that of vitamin C,

*Keywords: [*Côte d'Ivoire, Essential oils, antioxidant activity, *Cardiospermum grandiflorum }*

1. INTRODUCTION

For decades, plants have been used to treat and cure all kinds of illnesses. Advances in biotechnology, biochemistry and the search for new biologically active natural products are causing an ever-growing interest in natural resources [1]. Today, although we have seen the dramatic development of synthetic drugs, many even developed countries continue to rely

on traditional remedies. The World Health Organization (WHO) estimates that nearly 80% of the world's population mainly uses traditional medicine [2]. Herbal medicine research then becomes one of the greatest scientific concerns [3]. Several factors are behind this renewed interest such as the lower cost than conventional drugs, the relative availability especially in remote regions, mistrust of synthetic products or simply the desire to consume ' 'organic''. [4]. Due to the ignorance of their possible added values, aromatic plants are underestimated by populations who, however, are not unaware of their intrinsic natural properties. The reinforcement of research for a better knowledge of the chemical composition and the antioxidant activity of essential oils of aromatic plants is necessary to take advantage of their opportunities. It is for this purpose that this work was carried out to determine the chemical composition and antioxidant activity of the essential oil of the species of *Cardiospermum grandiflorum*, a species used in traditional settings [5]. *Cardiospermum grandiflorum* is a herbaceous to woody liana that can reach 10 m long. [6]. Native to warm regions of Africa and America, the species grows in semi-humid to humid environments, in warm temperate coastal regions and especially in subtropics and tropics [7]. The various extracts obtained from the leaves, stems and roots of the species are known for their many uses in traditional medicine [8]. In Côte d'Ivoire, the organs of the plant are used in different forms by the local populations in the treatment of diarrhea, edema, diabetes and bacterial infections [9]. To treat infantile convulsions, the Brong populations of Transua in eastern Côte d'Ivoire use the decocted of the leafy twigs either rectally or through the skin [10]. In Nigeria, a study was designed to assess the antibacterial interaction between the ethanolic extract of the leaves of the species and amoxicillin which is used as a bath sponge for the treatment of skin infections against *S. aureus.* Overall, the combined antimicrobial effect is synergistic against *S. aureus* [11]. In Côte d'Ivoire, recent work on the chemical composition and antioxidant activity of the essential oil of the fresh aerial parts of *C grandiflorum* has been carried out. The yellow EO has a yield of 0.08%. Analysis of the chemical composition identified 44 compounds representing 96.05% of the oil. It consists of 1.76% of hydrocarbon monoterpenes, 7.72% of oxygenated monoterpenes, 10.87% of oxygenated sesquiterpenes and 75.7% of hydrocarbon sesquiterpenes. The major compounds are: β-caryophyllene (17.09%), α-himachalene (14.86%), germacrene D (11.97%) and (E) -β-farnesene (11.35%). Antioxidant activity was assessed with the DPPH radical. The value of the 50% inhibitory concentration (IC50) is 0.95 µg / mL [7].

Studies of the chemical composition of the essential oils of the species have also been carried out by Nigerian researchers. The yields, of the EO of the dried and pulverized organs obtained by hydrodistillation, are respectively 0.37% for the leaves, 0.42% for the stems and 0.33% for the roots. The major compounds are isogermacrene (14.05%), caryophyllene oxide (29.49%) and α-octadecene (49.36%) [12].

This is why, in this work in order to contribute to the valorization of medicinal and aromatic plants of the Ivorian flora and also to contribute to boost the traditional medicine, we propose to determine the chemical composition and to evaluate the antioxidant activity by spectrophotometry of the essential oil of Cardiospermum. grandiflorum Sw.

2. MATERIAL AND METHODS

2.1 Plant material

The plant material consists of the aerial part (leaves, stems) of *Cardiospermum grandiflorum*. The first harvest was carried out on 01/29/21 in Langossou S / P Kokumbo in the BELIER region and the second harvest on 05/11/21 in the same region. The plant was identified and authenticated by a technician at the National Floristic Center (CNF) of Abidjan (Ivory Coast) using the existing herbarium (N°H UCJ 06284).

2.2. Methods

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2.2.1 Extraction of essential oil

The technical of steam distillation using a four-compartment stainless steel device was used to extract the essential oil from the plant matrix (MV). The boiler (60 l capacity) is connected to a large tank by a stainless steel pipe. The large tank (height: 100 cm, internal diameter: 51 cm or a volume of 0.2m^3) contains four grids attached to a removable rod. On the grids, the aerial part (18 kg) of withered plant material was placed (extraction 24 hours after harvest). From this tank, the water vapor drives the volatile compounds into a third tank (height: 100 cm, internal diameter: 41cm, i.e. a volume of 0.13m^3) which serves as a refrigerant. The EO are obtained in a fourth compartment serving as a recovery system. The essential oil is put in pill boxes wrapped in aluminum foil and then stored in a freezer at around 4 ° C [13].

2.2.2 Determination of the phytochemical composition

The analysis of the EO diluted in dichlorometane (1: 100) was carried out on a GC chromatograph (7890A, Agilent Technologies) coupled to a mass spectrometer (5975C, Agilent Technologies). A sample of HE (1 µl) was injected into an HP-5MS capillary column at 250 ° C. The oven temperature was programmed at 40 ° C for 5 min, then at 2 ° C / min for 15 min up to 250 ° C, with a flow rate of 10 ° C / min up to 300 ° C. Helium was used as carrier gas with a flow rate of 1mL / min. The MS detector had a temperature of 280 ° C and a voltage of 1.4 kV. The ions with a mass / charge ratio of between 40 and 500 were detectable. The identification of the compounds was carried out by comparison of the retention indices, calculated from retention times and mass spectra obtained with those from the National Institute of Standards and Technology (NIST) database and from the literature [7].

$$IR = 100\left[n + \frac{T_R(C_i) - T_R(C_n)}{T_R(C_{n+1}) - T_R(C_n)}\right]$$

RI: retention index or KI: Kovats index

Ci: Compound unknown to HE; C_n: linear alkane whose retention time is just before that of the unknown compound of the EO; n: carbon number of the linear alkane; C_{n+1}: linear alkane whose retention time is just after that of the unknown compound; T_R (Cn): Retention time of linear alkane with n carbon atoms eluted before the unknown compound; T_R (C_{n+1}): Retention time of the linear alkane with n + 1 carbon atoms eluted after the unknown compound

2.2.3. Evaluation of antioxidant activity.

The antioxidant potential of the extracts was evaluated using the Blois method.
The DPPH is dissolved in absolute ethanol to obtain a solution of 0.3 mM molar concentration. The solutions to be tested: are diluted in absolute ethanol in order to have the following concentrations in µg / mL: 2.5; 5; 10; 20; 50; 125; 250 and 500.
2.5 ml of test solution are introduced into dry and sterile hemolysis tubes and 1 ml of ethanolic solution of DPPH is added. After shaking, the tubes are placed in the dark for 30 min, protected from light.
For each solution to be tested, a blank is prepared consisting of 2.5 mL of pure absolute ethanol supplemented with 1 mL of ethanolic solution of DPPH.
For the negative control, a solution of DPPH is prepared by diluting 1 mL of the ethanolic solution of DPPH in 2.5 mL of ethanol. For the positive control, a solution of vitamin C (ascorbic acid) is used, the absorbance of which is measured under the same conditions.

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The measurement of the residual absorbance is carried out at 517 nm. It is translated into percentage inhibition by the following formula [14]:

$$\%I = (1 - \frac{\text{Abs test}}{\text{Abs DPPH}}) \text{ x100}$$

% I: Percentage inhibition. Abs test: Absorbance of ethanolic solution of essential oil and DPPH., AbsDPPH: absorbance of blank (ethanolic solution of DPPH).

3. RESULTS AND DISCUSSION

3.1. Extraction results

The essential oil obtained by steaming, with an aromatic odor and pale yellow color has a yield of (0.0045 ± 0.0002) %. Its density is about ($0.70 \pm 0{,}05$). This yield is 18 times lower than that of the work of authors Daouda T and collaborators, which is 0.08%. [7]. this difference could be related to environmental conditions (temperature, climate and humidity, duration of sunshine and peak of solar radiation, rainfall, altitude and nature of the soil), the harvest period and the extraction technical [15-17].

3.2. Phytochemical composition of essential oil.

The analysis of the chromatogram and mass spectra obtained by GC-MS identified 24 phytocompounds representing 99.45% of the total chemical composition. (Table 1). The chemical composition of essential oil consists mainly of hydrocarbon sesquiterpenes (97.72%). We note the presence of other compounds in small proportions (1.73%). The oxygenated sesquiterpenes are also in small proportions (1.73%). Monoterpenes are absent. The major compound is γ-muurolene (46.06%) (A) followed by β-Caryophyllene (24.35%) (B) and γ-elemene (7.07%) (C). The major compounds are represented in fig1

Table 1: Phytochemical composition of the EO of the aerial part of *Cardiospermum grandiflorum*

N°	T_R	RI	Compound	PM	%
1	33.81	1231.45	Cis 3Hhexenylisovalerate	184,16	0.53
2	39.94	1323.24	Undecylcyclohexane	238,8	0.16
3	4.,43	1330.80	δ-elemene	204	1.82
4	41.01	1339.41	α-longipinene	204	1.06
5	42.49	1362.90	Ylangene	204	2.06
6	43.30	1375.60	Decahydro-3a-méthyl-6-méthylène-1-(1-méthylethylcyclobuta [1.2.3.4] dicyclopentène	204	0.38
7	43.91	1385	Cis-β-elemene	204,3	0.87
8	44.41	1392.7	Neoisolongifolene	204	0.17
9	45.42	1409	β-Caryophyllene	204	24.35
10	46.00	1418.52	β-cubebene	204	0.22
11	46.49	1426.5	γ-elemene	204	0.43
12	47.03	1435.38	Epizonarene	204	0.97
13	47.49	1443	Humilene	204	2.60
14	48.18	1454	β-farnesene	204	4.16
15	49.31	1472.77	γ-muurolene	204	46.06

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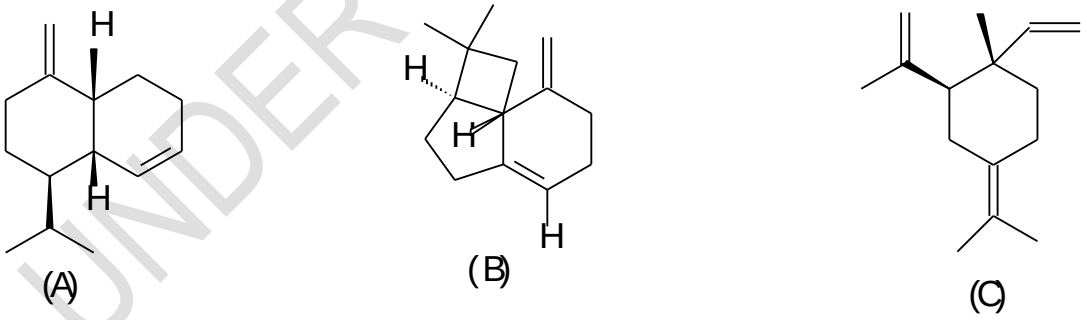
16	50.39	1490.5	β-himachalene	204	2 .71
17	50.89	1498	Cadina-1(10)4-diene	204	1.09
18	51.33	1506	α-himachalene	204	1.38
19	51.87	1515.77	β-cadinene	204	0.37
20	53.1	1517	GermacreneB	204	0.28
21	53.60	1545.77	γ-élémene	204	6.64
22	55.1	1571.5	Himachala-3(12) ,4-diene	204	1.02
23	57.9	1621.44	9,10-dehydroisolongifolene	200	0.45
24	59.06	1642.77	Diethylallylphosphonate	203	0.21
			Monoterpenes hydrocarbons		**0**
			Monoterpenes oxygenated		**0**
			Sesquiterpenes hydrocarbons		**97.72**
			Sesquiterpenes oxygenated		**1.73**
			Others		**1.73**
			Total		**99.45**

TR: Retention time; IR: retention index; PM: Molecular weight and %: percentage

The same major constituents were almost identified by [7] even though the samples were collected in December in Akouédo, we note a quantitative variation in the chemical composition. With β-caryophyllene (17.09%), (E) -β-farnesene (11.35%), germacrene-D (11.97%) and α-himachalene (14.86%) as the major compound and dominated by hydrocarbon sesquiterpenes (75.7%). This similarity could be due to the fact that Kokumbo and Abidjan are located in the same tropical zone. The results of the work of sheriff and collaborators are also dominated by hydrocarbon sesquiterpenes, but the dominant compound α-octadecene (49.36%) is, different from ours [12].
This variation in proportion may be related to the plant organ used, to the mutation factor, to the geographical origin and even to environmental factors and the technique of distillation. The structures of the major phytocompounds are shown in Figure1 and the proportions in Figure 2.



A:ɣ-muurolene; B: β-cariophyllene ; C: ɣ-elemene

Fig 1: **Majors phytocompounds of essential oil from the aerial part of *Cardiospermum grandiflorum* Sw**

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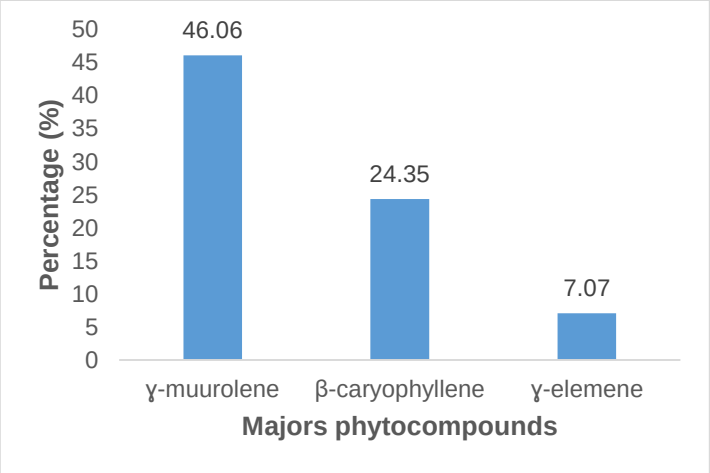

Fig 2: Proportions of the major phytocompounds

3.3. Antioxidant activity

Antioxidant activity was assessed spectrophotometrically. The absorbance of DPPH was measured at 517nm. The results (Figure 3) show that the EO extract of *C. grandiflorum* exhibits low antioxidant activity compared to vitamin C.

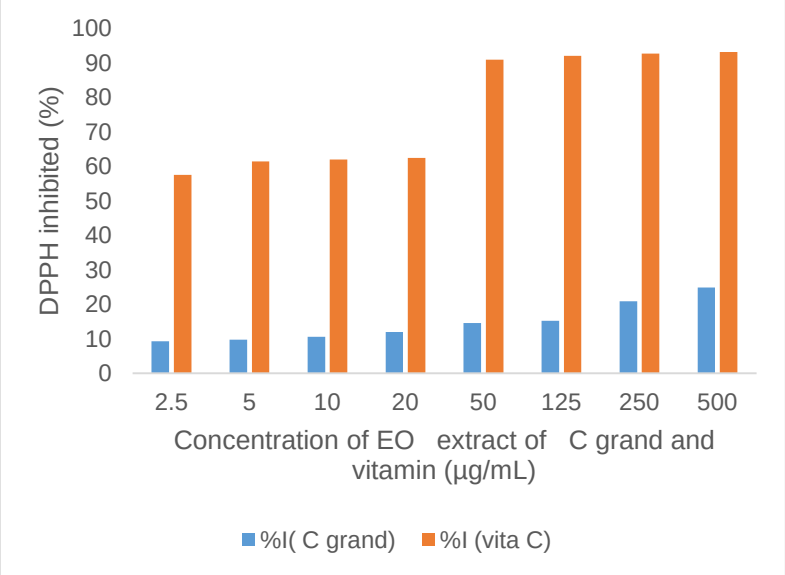

Fig 3: **Concentration dependent inhibition of DPPH**

This result is proved by the determined IC_{50} values. The IC_{50} value of vitamin C is 0.31 µg / mL while that of EO extract of *C grandiflorum* is 15.1 µg / mL. The IC_{50} of EO extract is 48 times higher than that of vitamin C, the standard antioxidant. This proves that vitamin C is 48 times more effective than EO extract. The relative antioxidant activity of EO extract could justify the use of this plant in traditional medicine. This antioxidant activity could be linked to the presence of terpenes [20]

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4. CONCLUSION

In the present study, we are interested in the valuation of *Cardiospermum grandiflorum* an aromatic plant used in traditional Ivorian medicine. The essential oil from the aerial part of the species, obtained by stripping with water vapor, has low yields. (0.0045 ± 0.0002)%.
Twenty four (24) phytocompounds were identified there. They consist essentially of hydrocarbon sesquiterpenes (97.72%). The oxygenated sesquiterpenes are in low proportion (1.73%); The other compounds are also in low proportions. Hydrocarbon and oxygenated monoterpenes are absent. The majority compounds are γ-muurolene (46.06%), β-Caryophyllene (24.35%), and γ-elemene (7.07%).
The study of antioxidant activity by the DPPH test, showed that the EO analyzed has less antioxidant activity than that of vitamin C, taken as a reference antioxidant. The IC50s are 0.31µg / mL for vitamin C, 15.1µg / mL for *C. grandiflorum*.

NOTE:

The study highlights the efficacy of " traditional medicine" which is an ancient tradition, used in some parts of africa. This ancient concept should be carefully evaluated in the light of modern medical science and can be utilized partially if found suitable.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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