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Chemical composition and antioxidant activity of essential oils from *Cinnamomum camphora* (L.) J. Presl (Lauraceae) and *Allanblackia parviflora* A. Chev (Clusiaceae)

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Abstract
The yield, chemical composition and antioxidant activity of *Cinnamomum camphora* (L.) J. Presl and *Allanblackia parviflora* A. Chev essential oils were determined after steam extraction. The yield of *Cinnamomum camphora* essential oil was 0.33±0.02%, compared with 0.01±0% for *Allanblackia parviflora* oil. These essential oils were analyzed by Gas Chromatography-Mass Spectrometry. *Cinnamomum camphora* oil is mainly made up of hydrocarbon monoterpenes (21.65%), oxygenated monoterpenes (73.92%), hydrocarbon sesquiterpenes (3.85%), oxygenated sesquiterpenes (0.27%) and other compounds (0.22%). The main compounds identified are: camphor (57.02%), eucalyptol (15.28%), α-pinene (7.45%) and β-pinene (4.01%). *Allanblackia parviflora* essential oil is made up of oxygenated monoterpenes (0.17%), hydrocarbon sesquiterpenes (80.05%), oxygenated sesquiterpenes (17.27%) and other compounds (2.32%). The dominant compounds are: α-caryophyllene (46.70%), caryophyllene (14.50%), humulene-1,2-epoxide (9.39%), β-selinene (8.72%). Evaluation of antioxidant activity revealed that the essential oils of *Cinnamomum camphora* (CR_{50}=0.038±0.01 mg/mL; vit C: CR_{50}=0.016±0.0089 mg/mL) and *Allanblackia parviflora* (CR_{50}=0.043±0.01 mg/mL; vit C: CR_{50}=0.016±0.0089 mg/mL) exhibited good antioxidant activity.

Keywords: *Cinnamomum camphora*, *Allanblackia parviflora*, essential oil, chemical composition, yield, steam training

1. Introduction
Medicinal plants are a fundamental component for the future of the global healthcare system, remaining an inexhaustible source of biologically active substances [1]. Their therapeutic properties have been tested since ancient times. Similarly, their valuable characteristics have been passed down orally from generation to generation or recorded in ancient writings [2]. Reputable remedies have prevailed despite the development of modern medicine, which tends to marginalize knowledge related to natural medical techniques [2]. However, this has not hindered the progress of research. Currently, the main concern of most researchers is the discovery of new molecules [1, 3, 4]. Essential oils are a very promising natural source, as they have significant antimiCRobial and antioxidant properties [1, 5, 6]. Thus, in order to contribute to the promotion of aromatic and medicinal plants in the Ivorian flora, we focused on two species, *Cinnamomum camphora* (L.) J. Presl and *Allanblackia parviflora* A. Chev [7]. It should be noted that *Cinnamomum camphora* is a tree that can grow to a height of 15 to 40 meters. It has been introduced in many other countries, including Australia [8], California in the United States, Argentina, India [9], Egypt, Madagascar, Spain, France, the Canary Islands [10], and Côte d'Ivoire. The essential oil extracted from this tree, obtained from the leaves and wood by steam distillation, is used by the Malagasy as a circulatory stimulant or anti-inflammatory. The leaves are also used in inhalation and steam baths to treat infectious diseases, respiratory tract conditions, and influenza. As an infusion, they are used to treat headaches and coughs [11]. *Allanblackia parviflora* A. Chev is a medium-sized tree that grows to a height of around 40 m [12]. It is found in forest areas from Guinea and Sierra Leone to Ghana [13]. In traditional medicine, the leaves are used in Côte d'Ivoire to treat stomach problems, fever, malaria, and joint pain [14]. The CRushed bark is used in Ghana as a painkiller for toothaches and to treat diarrhea [13].

2. Materials and Methods

2.1 Plant material

This consists of fresh leaves of *Cinnamomum camphora* harvested in Cocody Center (5° 23' 10.423" N 3°58' 57.866"W) and *Allanblackia parviflora* harvested in Djorobité in the municipality of Cocody (5° 25' 58.393" N 4° 2' 20.011" W). These municipalities belong to the Autonomous District of Abidjan in Côte d'Ivoire. The plants were identified using the herbariums of the National Floristic Center of Côte d'Ivoire (CNF) at Félix Houphouët-Boigny University (Abidjan/Cocody) under the numbers *UCJ008969* for *Cinnamomum camphora* and *WAG0060197* for *Allanblackia parviflora*.

2.2 Methods

2.2.1 Extraction of essential oil

A steam distillation technique using a stainless steel device with four compartments was used to extract the essential oil from the plant material. 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, volume: 0.2 m^3) contained four grids attached to a removable rod. On the grids, 1.2 kg and 4.5 kg of plant material were placed for each species separately. From this tank, the water vapor carries the volatile compounds into a third tank (height: 100 cm, internal diameter: 41 cm, volume: 0.13 m3) which serves as a condenser. The essential oil is obtained in a fourth compartment serving as a recovery system. It is then dried on anhydrous MgSO4 for about 10 minutes and stored in a pill box in the refrigerator at 4°C.

2.2.2 Analysis of the essential oil

The analysis of the essential oil diluted in dichloromethane (1:100) was performed on a GC chromatograph (7890A, Agilent Technologies) coupled with a mass spectrometer (5975C, Agilent Technologies). A sample of the essential oil (1µl) was injected into an HP-5MS capillary column at 250 °C. The oven temperature was set 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 the carrier gas at a flow rate of 1 ml/min. The MS detector has a temperature of 280 °C and a voltage of 1.4 kV. Only ions with a mass-to-charge ratio between 40 and 500 are detectable. Based on the retention times and mass spectra obtained with those from the National Institute of Standards and Technology (NIST) database and the literature.

$$\text{We have } Ir = 100\left[n + \frac{t_R(C_i) - t_R(C_n)}{t_R(C_{n+1}) - t_R(C_n)}\right]$$ [15, 16]

n: number of carbon atoms in the linear alkane preceding the unknown compound;
tR(ci): retention time of the unknown compound;
tR (cn): retention time of the linear alkane preceding the unknown compound; tR(cn+1): retention time of the linear alkane following the unknown compound; Ir : retention index of the unknown compound

2.2.2 Evaluation of the antioxidant activities of essential oils

2,2-Diphenyl-1-piCRylhydrazyl (DPPH) is solubilized in absolute methanol to obtain a solution with a concentration of 0.03 mg/mL. The concentrations of the various essential oil extracts in mg/mL prepared by successive dilution in absolute methanol are: 4; 2; 1; 0.5; 0.25; 0.125; 0.062; 0.031 and 0.015. In dry, sterile hemolysis tubes, 2.5 mL of the extract solution to be tested and 1 mL of the DPPH methanol solution are added. After shaking, the tubes are incubated for 30 min in the dark, then the absorbance of the mixture is measured at 517 nm. The blank consists of 2.5 mL of absolute methanol and 1 mL of DPPH solution. The positive reference control is vitamin C prepared under the same conditions as the samples. The reduction percentages (%R) of the samples are calculated from the measured absorbances [17, 18].

$$\%R = \left(1 - \frac{\text{Absorbance of the extract}}{\text{Absorbance of DPPH}}\right) \times 100$$

3. Results and discussion

3.1 Extraction of essential oils

The results relating to color, yield, and odor in relation to the technique used to extract essential oils from the plants studied are shown in (Table 1).

Table 1: Physical properties of extracted essential oils

Plants studied	*Cinnamomum camphora*	*Allanblackia parviflora*
Color	Colorless	Yellow
Odor	Aromatic	Aromatic
Yield (%)	0,33±0,02	0,01± 0

The yields of essential oils extracted by steam distillation from the leaves of *Cinnamomum camphora* and *Allanblackia parviflora* are low. However, Poudel *et al*. (2021) report a yield of 2.67% for *Cinnamomum camphora* leaves [19], which is approximately eight times higher than that obtained in the present study. Such differences can be attributed to various factors such as species, genotype, environmental conditions, harvest period, geographical origin, and the extraction technique used [20].

3.2 Chemical composition of extracted essential oils. 3.2.1- essential oil of *Cinnamomum camphora*

Analysis of the mass spectra and chromatogram of the essential oil from Cinnamomum camphora leaves identified 19 compounds representing (99.91%) of the total composition of the essential oil obtained by steam distillation (Table 2). The essential oil consists of hydrocarbon monoterpenes (21.65%), oxygenated monoterpenes (73.92%), hydrocarbon sesquiterpenes (3.85%), oxygenated sesquiterpenes (0.27%), and other compounds (0.22%). The main compounds are: camphor (57.02%), eucalyptol (15.28%), α-pinene (7.45%), and β-pinene (4.01%). Those obtained by hydrodistillation are: camphor (55.08%), followed by eucalyptol (10.62%), α-pinene (7.58%), and elixene (7.06%) [19]. These results show that the chemical composition of the essential oil from *Cinnamomum camphora* leaves obtained by steam distillation is significantly different from that obtained by hydrodistillation. This difference could be explained mainly by the specific extraction conditions for each extraction method, but also by variations in certain experimental parameters. For example, according to Kouassi (2022) [20], the high sensitivity of the unsaturated compounds that make up essential oils causes certain changes from one experimental environment to another. More specifically, variations in certain parameters in the essential oil's environment (temperature, light, contact with water, etc.) are likely to alter its chemical composition.

Table 2: Chemical composition of *Cinnamomum camphora* essential oil obtained by steam distillation

N°	Compounds	Tr (min)	Ir	m/z	Content (%)
1	β-thujene	12.31	920	136	0.37
2	α-pinene	12.62	924	136	7.45
3	camphene	13.49	938	136	3.48
4	β-pinene	15.34	967	136	4.01
5	β-myrcene	16.75	988	136	3.08
6	α-phellandrene	17.38	998	136	0.54
7	α-terpinene	18.25	1011	136	0.11
8	eucalyptol	19.14	1023	154	15.28
9	acetophenone	20.79	1046	120	0.22
10	α-terpinolene	21.32	1054	136	0.24
11	4-ethenyl-1, 5,5-trimethylcyclopentene	23.40	1083	136	0.55
12	camphre	27.13	1135	152	57.02
13	borneol	28.76	1158	154	0.18
14	α- terpineol	29.62	1171	154	0.95
15	4-carene	30.63	1185	136	1.82
16	eugenol	45.41	1409	164	0.49
17	α-caryophyllene	47.53	1443	204	1.14
18	bicyclogermaCRene	50.19	1487	204	2.71
19	germaCRene D-4-ol	54.89	1568	222	0.27
	Hydrocarbon monoterpenes				21.65
	Oxygenated monoterpenes				73.92
	Hydrocarbon sesquiterpenes				3.85
	Oxygenated sesquiterpenes				0.27
	Others				0.22
	Total				99.91

Tr: Retention time; Ir: Retention index; m/z: Mass to charge ratio;%: Percentage

Table 3: Chemical composition of *Allanblackia parviflora* essential oil obtained by steam distillation

N°	Compounds	Tr	Ir	m/z	Content (%)
1	camphor	27.150	1135	152	0.17
2	β-damascone	42.479	1362	192	0.29
3	α-copaene	42.802	1367	204	0.81
4	β –damascenone	43.930	1385	190	0.29
5	α-cedrene	44.936	1401	204	0.21
6	caryophyllene	45.434	1409	204	14.50
7	α-damascone	46.694	1430	190	1.58
8	α-caryophyllene	47.568	1444	204	46.70
9	β-humulene	48.002	1451	204	0.63
10	γ-muurolene	48.119	1453	204	0.60
11	β-guaiene	48.998	1467	204	0.48
12	germaCRene D	49.586	1477	204	2.43
13	β –selinene	50.242	1488	204	8.72
14	α-farnesene	51.164	1503	204	3.97
15	δ-selinene	51.979	1517	204	1.00
16	Hedycaryol	53.425	1542	204	0.28
17	Nerolidol	54.452	1560	222	0.59
18	Epoxycaryophyllene	55.098	1572	220	4.33
19	Guaiol	56.189	1590	222	1.15
20	humulene-1,2-époxide	56.618	1598	220	9.39
21	γ-eudesmol	57.709	1618	222	0.73
22	épi- cubenol	57.910	1621	222	0.45
23	agarospirol	59.160	1644	222	0.09
24	valeranone	60.240	1664	222	0.13
25	eudesm-7(11)-en-4-ol	61.230	1682	222	0.13
26	palmitic acid	75.273	1960	256	0.16
	Oxygenated monoterpenes				0.17%
	Hydrocarbon sesquiterpenes				80.05%
	Oxygenated sesquiterpenes				17.27%
	Others				2.32%
	Total				99.81%

Tr: Retention time; Ir: Retention index; m/z: Mass to charge ratio;%: Percentage

3.3 Antioxidant activity of extracted essential oils

3.3.1 Antioxidant activity of *Cinnamomum camphora* essential oils: The ability of essential oils obtained by steam distillation of *Cinnamomum camphora* to trap the DPPH radical was evaluated by measuring its absorbance at different concentrations. The results obtained are presented below in the form of histograms (Figure 1).

% R (EO-SD/Cc): percentage reduction of *Cinnamomum camphora* essential oil obtained by steam distillation;% R (vit C): percentage reduction of vitamin C.

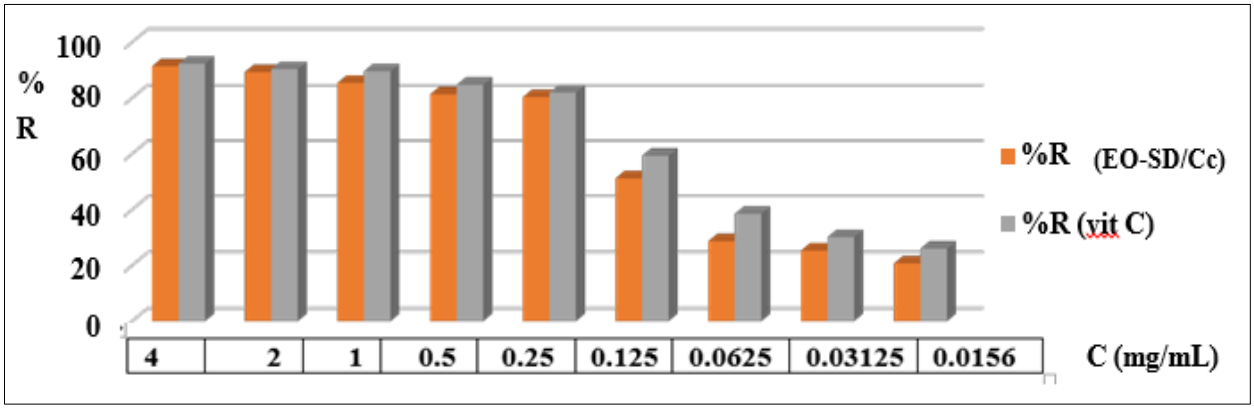

Fig 1: Histogram of DPPH inhibition as a function of the concentration of *Cinnamomum camphora* essential oil

Looking at the inhibition histogram, with an IC_{50} of 0.038±0.01mg/mL for *Cinnamomum camphora* essential oil, compared to an IC50 of 0.016±0.0089 mg/mL for vitamin C, it can be seen that *Cinnamomum camphora* essential oil exhibits good antioxidant activity. However, another study reported an IC50 of 6.887±0.151 mg/mL for *Cinnamomum camphora* essential oil, indicating moderate antioxidant activity [24]. As for the activity of our extract, it is probably linked to the presence of α-pinene (7.45%), β-pinene (4.01%) and camphor (57.02%) according to Obame *et al*. (2008) [25]. These compounds are known for their remarkable antioxidant activities, according to Konan *et al*. (2011) and Atittallah (2013) [3, 26].

3.3.2 Antioxidant activity of *Allanblackia parviflora* essential oils: Analysis of the antioxidant properties of *Allanblackia parviflora* essential oils using the 2,2-diphenyl-1-piCRylhydrazyl (DPPH) method yielded different concentrations of free radical inhibition (Figure 2).
% R (EO-SD/Ap): percentage reduction in *Allanblackia parviflora* essential oil obtained by steam distillation;% R (vit C): percentage reduction in vitamin C.

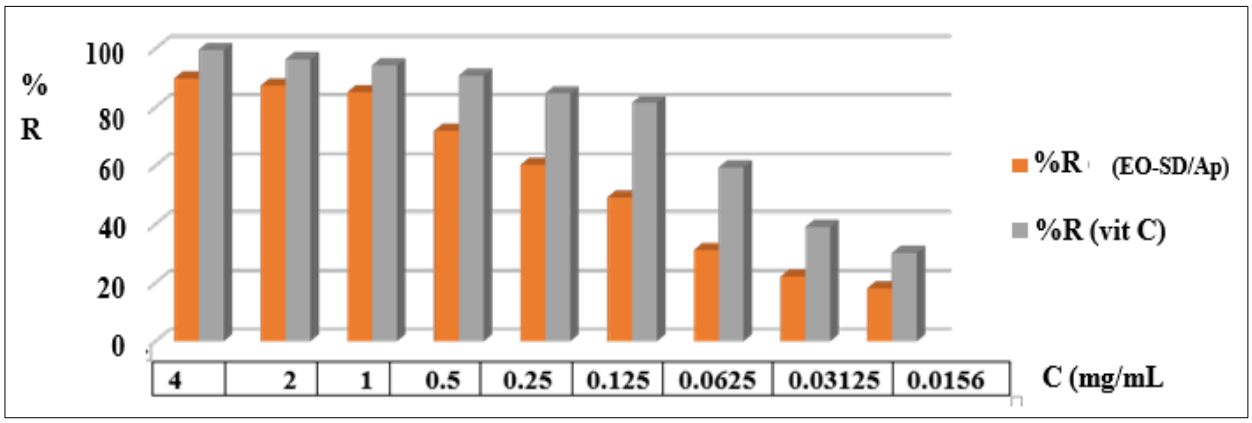

Fig 2: Histogram of DPPH inhibition as a function of the concentration of *Allanblackia parviflora* essential oil

By observing the histogram, the $_{CR50}$=0.055±0.01 mg/mL of *Allanblackia parviflora* essential oil and the $_{CR50}$=0.016±0.0089 mg/mL of vitamin C, we can deduce that *Allanblackia parviflora* essential oil exhibits good antioxidant activity. This activity could be attributed to the presence of α-caryophyllene (46.70%) and caryophyllene (14.50%), whose antioxidant capacities have been reported in the literature, notably by Tepe *et al*. (2005) and Obame *et al.* (2008) [25, 27].

4. Conclusion

This study is part of an effort to promote two species of Ivorian flora. These are *Cinnamomum camphora* and *Allanblackia parviflora*. The study of their essential oils showed that both species produced oil with very low yields, 0.33±0.02 for *Cinnamomum camphora* and 0.01±0 for *Allanblackia parviflora*. Analysis of these oils using gas chromatography coupled with mass spectrometry (GC-MS) enabled them to be characterized. *Cinnamomum camphora* oil is dominated by oxygenated monoterpenes (73.92%) with camphor (57.02%) as the main compound. Furthermore, Allanblackia parviflora is dominated by hydrocarbon sesquiterpenes (80.05%), of which α-caryophyllene (46.70%) is the major compound. Antioxidant activity revealed that the essential oils of *Cinnamomum camphora* (EC50=0.038±0.01 mg/mL; vitamin C: $_{CR50}$=0.016±0.0089 mg/mL) and *Allanblackia parviflora* ($_{CR50}$=0.043±0.01 mg/mL; vitamin C: $_{CR50}$ =0.016±0.0089 mg/mL) showed remarkable antioxidant power.

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References

1. Sadou N, Seridi R, Djahoudi R, Hadef Y. Chemical composition and antibacterial activity of essential oils from *Pinus halepensis* Mill needles from northeastern Algeria. Rev Sci Technol Synthèse. 2015;30:33-9.
2. Kabera J, Koumaglo KH, Ntezurubanza L, Ingabiré MG, Kamagaju L. Characterization of essential oils from

Hyptis spicigera Lam, *Pluchea ovalis* (Pers) C.C., and *Laggera aurita* (L.F.) Benth. ex Clarke, tropical aromatic plants; 2004, p.1-10.
3. Konan NS, Kouamé BA, Bossoh AM, Mamyrbekova-Békro JA, Konan KM, Nemlin GJ, *et al*. Chromatographic study and antioxidant activity of the essential oil of *Afraegle paniculata* (Rutaceae). Eur J Sci Res. 2011;63(4):482-488.
4. Modzelewska A, Sur S, Kumar K, Khan S. Sesquiterpenes: Natural products that deCRease cancer growth. Curr Med Chem Anticancer Agents. 2005;5:477-499.
5. Pionchon M. Study of essential oils from plant species in the Laurentian flora: chemical composition, pharmacological activities, and hemi-synthesis [Doctoral thesis]. Quebec (Canada): University of Quebec; 2008, p. 155.
6. Goudjil M. Chemical composition, antimiCRobial and antioxidant activity of three aromatic plants [Doctoral thesis]. Ouargla (Algeria): University of Ouargla; 2016, p. 108.
7. Alenyorege EA, Ayim I, Aheto JH. Uniqueness of Allanblackia seed oil: prospects and potential in Ghana, Review; 2017, p. 22-9.
8. Frizzo CD, Santos AC, Paroul N, Serafini LA, Dellacassa E, Lorenzo D, *et al*. Essential oils of camphor tree (*Cinnamomum camphora* Nees & Eberm) cultivated in southern Brazil. Braz Arch Biol Technol. 2000;43(3):313-316.
9. Hamzi W. Experimental and in silico study of the biological activity of certain derivatives of the camphor molecule and its antiviral activity [Doctoral thesis]. Oran (Algeria): University of Science and Technology of Oran Mohamed Boudiaf; 2020, p. 156.
10. Schenk JR. Phytochemistry, allelopathy and the capability attributes of camphor laurel (*Cinnamomum camphora* (L.) Ness & Eberm.) [Ph.D. thesis]. Lismore (NSW): Southern CRoss University; 2009.
11. Randevoson MNM. Contribution to the CReation of the Malagasy pharmacopoeia [Agricultural Engineering thesis]. Antananarivo (Madagascar): University of Antananarivo; 2004, p. 168.
12. Hawthorne W, Gyakari N. Photo guide to Ghana's forest trees: A field guide for identifying large trees. Oxford: Oxford Forestry Institute; 2006, p. 1-432.
13. Ofori DA, Peprah T, Cobbinah JR, Atchwerebour HA, Osabutey F, Tchoundjeu Z, *et al*. Germination requirements of *Allanblackia parviflora* seeds and early plant growth. 2011;41:337-48.
14. Tra Bi FH, Sylla Y, Silué DK, Quattara K, Koné MW. Ethnobotanical studies on plants used for the treatment of malaria in Côte d'Ivoire. Rev Méd Pharm Afr. 2007;21:35-45.
15. Paolini J. Characterization of essential oils by GC/IR, GC/MS (IE and IC) and carbon-13 NMR of *Cistus albidus* and two Asteraceae endemic to Corsica: *Eupatorium cannabinum* subsp. *corsicum* and *Doronicum corsicum* [Doctoral thesis]. Corsica (France): University of Corsica; 2005, p. 342.
16. Daouda T. Chemical and biological studies of essential oils from four aromatic medicinal plants from Côte d'Ivoire [Doctoral thesis]. Abidjan (Côte d'Ivoire): Félix Houphouët-Boigny University; 2015, p. 154.
17. Tanoh SK, Kouassi NCC, Boa D, Békro MAJ, Békro YA. Antioxidant activity of CRude hydroethanolic and hydroacetonian extracts from the organs of four medicinal plants from Côte d'Ivoire. Nat Tech. 2019;22:1-7.
18. Etekpo DS, N'gamen K, Mamyrbekova-Békro AJ, Békro YA. Antioxidant profiles of alcoholic tinctures from *Heterotis rotundifolia* (SM) Jacq.-Fel. (Melastomaceae) by DPPH radical trapping. Eur J Biomed Pharm Sci. 2018;5(10):39-45.
19. N'dri K. Chemical composition and biological study of five aromatic and medicinal plants from the Ivorian flora according to the extraction method [Doctoral thesis]. Abidjan (Côte d'Ivoire): Nangui Abrogoua University; 2025, p. 162.
20. Kouassi KS. Chemical composition, antioxidant and antimiCRobial activities of essential oils from five aromatic and medicinal plants from Côte d'Ivoire: Comparative study of hydrodistillation and steam distillation [Doctoral thesis]. Abidjan (Côte d'Ivoire): Nangui Abrogoua University; 2022, p. 203.
21. N'dri K, Atsain M, Konan N, Kouame B, Békro MJA, Békro YA. Chemical composition and antibacterial activities of essential oils extracted from the leaves of *Harungana madagascariensis* Lam. Ex Poiret (Hypericaceae) and *Allanblackia parviflora* A. Chev (Clusiaceae). Int J Pharm Sci Rev Res. 2023;41:277-82.
22. Boutekedjiret C, Bentahar F, Belabbes R, Bessière JM. Extraction of rosemary essential oil by steam distillation and hydrodistillation. Flavour Fragr J. 2003;18(6):481-4.
23. Okoh OO, Sadimenko AP, Afolayan AJ. Comparative evaluation of the antibacterial activities of *Rosmarinus officinalis* L. essential oils obtained by hydrodistillation and solvent-free miCRowave extraction methods. Food Chem. 2010;120(1):308-312.
24. Zhang B, Ling Q, Wang Y, Hou J, Xiao C, Liu Y, *et al*. Chemical composition and antioxidant activity of the essential oils of citral-rich chemotype *Cinnamomum camphora* and *Cinnamomum bodinieri*. Molecules. 2022;27(21):7356.
25. Obame LC, Edou P, Bassolé IHN, Koudou J, Agnaniet H, Eba F, *et al*. Chemical composition, antioxidant and antimiCRobial properties of the essential oil of *DaCRyodes edulis* (G. Don) HJ Lam from Gabon. Afr J MiCRobiol Res. 2008;2:148-52.
26. Atittallah N. Extraction and bioactivities of essential oils from two Algerian aromatic plants [Master's Thesis]. M'Sila (Algeria): University of M'Sila; 2013, p. 64.
27. Tepe B, Sokmen M, Sokmen A, Daferera D, Polissiou M. AntimiCRobial and antioxidative activity of the essential oil and various extracts of *Cyclotrichium origanifolium* (Labill.) Manden. & Scheng. J Food Eng. 2005;69:335-342.