HEMI-SYNTHESIS AND UV-VISIBLE SPECTROPHOTOMETRIC CHARACTERIZATION OF 2,4-DINITROPHENYLHYDRAZONES DERIVED FROM CITRAL AND CITRONELLAL ESSENTIAL OILS OF TWO AROMATIC PLANTS ACCLIMATIZED IN CONGO-BRAZZAVILLE

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Abstract
The orange-yellow and colorless essential oils with respective yields of 1.54% and 3.59% were extracted from the dry leaves of *Cymbopogon citratus* (DC.) Stapf and *Eucalyptus citriodora* Hook. collected south of Brazzaville. Analysis by gas chromatography (GC) and by gas chromatography coupled with mass spectrometry (GC/MS) allowed the identification of fifteen (15) and eight (8) constituents representing (96.25%) and (98.46%) of total essential oils respectively. *Cymbopogon citratus* oil consists mainly of geranial (51.99%) and nerol (32.94%), two geometric isomers constituting citral which occupies a rate of 84.93%. While citronellal with a high level of (80.72%) and citronellol (10.48%) are the major compounds of the essential oil of *Eucalyptus citriodora*. Geranial (citral a) and citronellal 2,4-dinitrophenylhydrazones were hemi-synthesized by a simple, easy method, respectively from essential oils of *Cymbopogon citratus* and *Eucalyptus citriodora* with respective conversion rate (yields) of 20% and 37%, in a short time (three to five minutes). Analysis of geranial and citronellal 2,4-dinitrophenylhydrazones by UV-visible spectrophotometry showed maximum absorption wavelengths of 390 nm and 370 nm respectively. The UV-visible spectrophotometric method employed for the determination of these hydrazones is convenient, fast and simple. The hemi-synthesized hydrazones could be useful in the pharmaceutical industry, in perfumery, cosmetic and in biomedicine.

Introduction:-
Among the organic compounds contained in the essential oils of certain aromatic plants are carbonyl compounds (aldehydes and ketones) with high proportions reaching 85%. This is the case of citral (geranial and neral) and citronellal in the essential oils of *Cymbopogon citratus* and *Eucalyptus citriodora* respectively (Ndzeli et al., 2019a; Ndzeli et al., 2019b). These are chemical compounds which have a remarkable interest, intervening in a wide field of application (cosmetics, perfumery, pharmaceuticals, food industry, chemical industry). They are endowed with various chemical properties due to the presence of the C=O double bond giving rise to several nucleophilic and electrophilic addition reactions (Vollhard, 1995). However, the main disadvantage or disadvantage of these

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compounds is their instability which often results in oxidations, hence the need to convert them into hydrazones, crystalline compounds more stable than their precursors (carbonyls) (Quédraogo et al., 2009; Adjeroud, 2017).

**Hydrazones are organic compounds of the general formula:**
RR'C=N−N−R''R '''. 2,4-Dinitrophenylhydrazones are substituted hydrazones, derived from the condensation of an aldehyde or a ketone with 2,4-dinitrophenylhydrazine (Hany et al., 2015) (Figure 1); a reversible reaction subjected to acid catalysis (Rauk, 2001). They play an important role in the protection of carbonyl compounds (Greene et al.; 1999). They are also used for the isolation, purification and characterization of the carbonyl group (Shriner et al., 1980) and as an intermediate in organic synthesis (Armbruster et al., 2006). Furthermore, hydrazones are used for the extraction or determination of transition metals such as iron (Shobha, 2011), molybdenum (Battula et al., 2012) by formation of hydrazonic metal complexes.

Regarding pharmacology, many studies affirm that hydrazones have various biological properties: antimicrobial, (Maldovan et al., 2012, Alberta Ade et al., 2020), antibacterial (Azim et al., 2014), (Ümmühan et al., 2008); antioxidant (Belkheire et al., 2010); analgesic, anti-inflammatory (Mohammad and Asif, 2013); antitoxoplasma, antimalarial, anticoagulant, anticonvulsant, antihypertensive, antitumor (Singh and Raghv, 2011). In addition, hydrazones are endowed with pesticide activities (Ali et al., 2009), antiviral, protozoan and antifungal activities (Sevim et al., 2007; Mehan et al., 2019; Ortiz et al., 2016).

It should be noted that the metal complexes derived from hydrazones are used in the treatment of tuberculosis (Srimam et al., 2005).

To these biological properties are added electrochemical properties (Torje et al., 2012).

Several syntheses of 2,4-dinitrophenylhydrazones from marketed aldehydes and ketones have been reported in the literature (Monfared et al., 2007; Al-Rekabi, 2011; Anwar and Nour, 2016; Dinore et al., 2016; Iqbal et al., 2019). Very few studies on the hemi-synthesis of hydrazones derived from aldehydes and ketones of essential oils are described in the literature. We can cite the hemi-synthesized hydrazones of essential oils with an aldehyde chemotype (cuminaldehyde and perillaldehyde) recently carried out in Algeria (Bouchachia and Ameur, 2019).

To our knowledge, the hemi-synthesis of 2,4-dinitrophenylhydrazones from the aldehydes (citral and citronellal) of essential oils is not known.

Various analytical techniques including GC-MS (Tai-sheng et al., 2013); LC-MS (Akdo et al., 2011), HPLC (Jianrong et al., 2007) are used for the determination of 2,4-dinitrophenylhydrazones. However, these analytical methods involve long analysis time, tedious sample pretreatment, and high product cost.

The aim of this present work is to extract essential oils, to hemi-synthesize and to characterize 2,4-dinitrophenylhydrazones derived from citral and citronellal by UV-Visible spectrophotometry, a simple and rapid method.

**Materials and Methods:**

**Plant material:**
Samples of *Cymbopogon citratus* (DC.) Stapf and *Eucalyptus citriodora* Hook. (Figure 2 and 3) were collected in January 2019 in the southern districts of Brazzaville (Makelekelé), respectively in the garden of the Library of the
University Marien NGOUABI and in the garden of the General Directorate of Examinations and Competitions. They were identified by botanists from the National Herbarium of the Congo. Only leaves were selected for the study.

Figure 2: Cymbopogon citratus
Figure 3: Leaves of the species (DC.) Stapf species Eucalyptus citriodora Hook.

Extraction of essential oils:
After eight (8) days of drying at room temperature, in a ventilated room, the samples of Cymbopogon citratus and Eucalyptus citriodora made up of the leaves are subjected to hydrodistillation for four (4) hours using an extractor Clavenger type (Clavenger, 1928), fitted with a two (2) liter balloon. The condensate loaded with essential oil and hydrolate is collected. The essential oil is separated from the hydrolate by decantation. The extraction with diethyl ether is carried out to isolate the aqueous phase of the essential oil followed by drying of the ether phase with anhydrous sodium sulfate. Twenty-four (24) hours after evaporation of the diethyl ether in air, the essential oil is recovered. These operating conditions are summarized in Table I. The yield R in essential oil is calculated according to the following formula.

Tableau I: Operating conditions for hydrodistillation of leaves of Cymbopogon citratus (DC.) Stapf and Eucalyptus citriodora Hook.

| Vegetable matter organs | Cymbopogon citratus | Eucalyptus citriodora |
|-------------------------|---------------------|-----------------------|
|                         | Leaves              | Leaves                |
| Quantity of matter dry (g) | 183                 | 155                   |
| Quantity of water (L)       | 1                   | 1                     |
| Execution time of the operation (h) | 4                   | 4                     |

Analysis of essential oils:
Analysis by gas chromatography:
The quantification of the constituents was carried out using a Hewlett Packard HP 5890 type chromatograph equipped with a flame ionization detector equipped with HP ChemStation data acquisition software. The different constituents are separated using a DB5 capillary column (30 mx 0.25 mm), (film thickness 0.25 µm) under the following operating conditions: helium carrier gas (1 mL.min⁻¹), temperature injector temperature: 280 °C, detector temperature: 280 °C. The oven is programmed at 50 °C for 5 minutes with a gradient of 5 ° C.min⁻¹ from 50 to 300 °C, 5 minutes at 300 °C with a split mode injection of 1:20.

Analysis by gas chromatography-mass spectrometry:
Analysis by gas chromatography-mass spectrometry was carried out using a Hewlett Packard HP 6890 brand chromatograph coupled to an HP 5973 mass spectrometer. The various constituents are separated using a DB5 capillary column (30 mx 0.25 mm), (film thickness 0.25 µm) under the following experimental conditions: carrier
Identification of constituents:
The various constituents of essential oil have been identified on the basis of their retention indices and their mass spectra by comparison with data from the literature (Adams, 2001; Joulain et al., 1998; Davies, 1990).

Hemi-synthesis of 2,4-dinitrophenylhydrazones:
The 2,4-dinitrophenylhydrazine reagent and essential oils from the species Cymbopogon citratus and Eucalyptus citriodora are used for the preparation of hydrazones.

The method used has been reported by (Leclercq, 2008). It consists of dissolving 0.25 g of 2,4-dinitrophenylhydrazine in 5 mL of methanol, followed by addition of 0.5 mL of concentrated sulfuric acid, then filtration of the lukewarm solution. To this solution are added 0.2 g of essential oil previously solubilized in a small volume of methanol. After about three (3) to five (5) minutes, the solid formed is filtered off and washed in a little methanol. If there is no solid, the solution is acidified with sulfuric acid. The precipitate is then recrystallized from ethanol and then dried. These conditions are summarized in (Table II).

Tableau II:- Operating conditions for the synthesis of 2,4-dinitrophenylhydrazones.

| Essential oils       | Quantity of reagent (g) | Quantity of EO (g) | Quantity of MeOH (mL) | Quantity of H₂SO₄ (mL) |
|----------------------|-------------------------|--------------------|-----------------------|------------------------|
| Cymbopogon citratus  | 0.25                    | 0.2                | 5                     | 0.5                    |
| Eucalyptus citriodora| 0.25                    | 0.2                | 5                     | 0.5                    |

Characterization of 2,4-dinitrophenylhydrazones:
Determination of melting points:
The measurement of the melting temperatures of the prepared hydrazones is carried out using the kofler bench. The method consists of calibrating the device with benzoic acid which has a melting point of 122.35 °C. The carriage is moved horizontally until the cursor is at the border between solid and liquid. Then the movable index is moved vertically until it indicates the melting point of the standard. The hydrazone's melting point is then taken by depositing it at the cold end of the kofler bench and moving it towards the hot zone until the first drops of liquid appear. The carriage is then moved horizontally until the cursor is at the border between solid and liquid. The moving index then indicates the melting point. Three tests are carried out.

UV-visible spectrophotometric analysis:
The analysis of 2,4-dinitrophenylhydrazones is done by a UV-visible WPA Lightwave II spectrophotometer, connected to an HP computer.

Preparation of solutions:
2,4-Dinitrophenylhydrazine solution:
A solution of 2,4-dinitrophenylhydrazine is prepared by dissolving 0.3 g of 2,4-dinitrophenylhydrazine in 100 mL of a 0.05 M sulfuric acid solution.

Essential oil solution:
The essential oil (10 to 20 mg) is placed in a 10 mL vial in which methanol is added to the mark.

Spectral scan:
2,4-dinitrophenylhydrazones scan:
0.5 mL of the 2,4-dinitrophenylhydrazine solution is added to 0.5 mL of the essential oil solution. An orange or brown precipitate forms depending on the essential oil used. The precipitate is left to stand for 10 minutes at room temperature and 5 ml of methanol are added to it: This is the solution of 2,4-dinitrophenylhydrazone.
We put in the reference tank:
• 1 mL of the 30% (V/V) water/ethanol solvent
and in the measuring tank:
• 1 mL of the 2,4-dinitrophenylhydrazone solution

Results and discussion:

Extraction and yield of essential oils:

Hydrodistillation extraction from the dry leaves of *Cymbopogon citratus* from *Eucalyptus citriodora* provides orange-yellow and colorless essential oils with yields of 1.54% and 3.59% respectively (Table III). The yield of *Eucalyptus citriodora* essential oil (3.59%) is higher than that of *Cymbopogon citratus* essential oil (1.54%). *Eucalyptus citriodora* essential oil can be produced in high yields of up to 4-6% (Mapola, 2004). The result of the extraction yield of the essential oil of *Eucalyptus citriodora* agrees with that described in Congo indicating a yield of 3.57% (Silou, et al., 2013), while that of the oil of *Cymbopogon citratus* (DC.) Stapf (1.54%) is similar to that of essential oil of Togolese origin, which has a value of 1.60% (Koba et al., 2009).

Tableau III :- Extraction yield of essential oils from the leaves of *Cymbopogon citratus* (DC.) Stapf and *Eucalyptus citriodora* Hook.

| species                          | yield (%) | Our study | Previous studies / origin |
|----------------------------------|-----------|-----------|---------------------------|
| *Cymbopogon citratus* (DC.) Stapf| 1.54      |           | 1.60 (Koba et al., 2009)/Togo |
| *Eucalyptus citriodora* Hook.    | 3.59      |           | 3.57 (Silou et al., 2013) /Congo |

Chemical composition of essential oils:

*Cymbopogon citratus*:

The results of the chemical analysis of the essential oil extracted from the leaves of *Cymbopogon citratus* are shown in (table VI). In total, fifteen (15) constituents were identified representing (96.25%) of the chemical composition of the total essential oil. The essential oil is rich in monoterpenes (95.87%) with a dominance of oxygenates (90.24%) of which the most remarkable are géranial (51.99%) and neral (32.94%), two geometric isomers constituting the citral which occupies a rate of 84.93%. Hydrocarbon monoterpenes represent a rate of 5.63% with mainly myrcene (5.52%) and (Z)-ocimene (0.11%) as components.

In the group of sesquiterpenes, the hydrocarbon compounds are represented by a single constituent, β caryophyllene, which occupies a very low level of (0.07%). We note the absence of oxygenates. These results are qualitatively in agreement with those of the literature which describe samples containing citral proportions of 79.28% and 100% respectively (Silou et al., 2017; Barreira et al., 2004).

Tableau VI:- Chemical composition of the essential oil of *Cymbopogon citratus* (DC.) Stapf.

| Nº | Compounds       | Tr     | %     |
|----|-----------------|--------|-------|
| 1  | 6-Methyl-5-Heptene one | 6.09   | 0.31  |
| 2  | Myrcene         | 6.13   | 5.52  |
| 3  | (Z)-β-Ocimene   | 7.03   | 0.11  |
| 4  | Linalool        | 8.16   | 0.68  |
| 5  | Isopulegol      | 8.95   | 0.16  |
| 6  | Citronellal     | 9.01   | 0.53  |
| 7  | Terpinene-4-ol  | 9.45   | 0.48  |
| 8  | Nerol           | 10.13  | 0.07  |
| 9  | Citronellol     | 10.16  | 0.45  |
| 10 | Neral           | 10.34  | 32.94 |
| 11 | Lynalyl acetate | 10.50  | 2.34  |
| 12 | Geranial        | 10.78  | 51.99 |
| 13 | Citronellyl acetate | 11.87 | 0.29  |
| 14 | Geranyl acetate | 12.24  | 0.31  |
| 15 | β-Caryophyllene | 12.78  | 0.07  |

| Total compounds identified | 96.25 |
| Oxygenated monoterpenes    | 90.24 |
| Hydrocarbonsmonoterpenes    | 5.63  |
Eucalyptus citriodora:
Table V collates the results of the chemical analysis of the essential oil extracted from the leaves of *Eucalyptus citriodora*. In total, eight (8) constituents were identified representing (98.46%) of the chemical composition of the total essential oil. The essential oil is characterized by a large amount of monoterpenes (97.96%) dominated by oxygenated monoterpenes (97.20%) of which the major compounds are citronellal with a high rate of (80.72%), citronellol (10.48%), lisopulegol (3.91%). We note the presence of a single hydrocarbon compound, β-pinene, which occupies a low level of (0.76%). The sesquiterpenes group remains marked by a single hydrocarbon compound, E caryophyllene, the level of which is low, amounting to (0.13%). Aliphatic compounds are characterized by ethylenic aldehyde 2,6 dimethyl hept-5-en-1-al in such a low proportion (0.37%).

These results agree qualitatively with those of *Eucalyptus citriodora* of Algerian origin, with citronellal (69.77%), citronellol (10.63%) and isopulegol (4.66%) as major compounds (Tolba et al, 2015). Also the sample of Ethiopian origin shows a chemical composition dominated by citronellal (73.86%) and citronellol (14.13%) (BekriMelka, 2019).

| Nº  | Compounds            | IK    | %     |
|-----|----------------------|-------|-------|
| 1   | β-Pinene             | 977   | 0.76  |
| 2   | 1,8 Cineole          | 1033  | -     |
| 3   | Melonal              | 1052  | -     |
| 4   | Linalol              | 1100  | -     |
| 5   | 2,4 Dimethylhept-5-en-1-al | 1150 | 0.37 |
| 6   | Isopulegol           | 1152  | 3.91  |
| 7   | Citronellal          | 1154  | 80.72 |
| 8   | (iso) isopulegol     | 1161  | 0.24  |
| 9   | Citronellol          | 1230  | 10.48 |
| 10  | Citronellyl format   | 1276  | -     |
| 11  | Thymol               | 1296  | -     |
| 12  | Thymyl acetate       | 1355  | -     |
| 13  | Eugenol              | 1362  | -     |
| 14  | Methyleugenol        | 1404  | 1.85  |
| 15  | E-Caryophyllene      | 1426  | 0.13  |
| 16  | a-Gurjunene          | 1430  | -     |

Total compounds identified | 98.46 |
Oxygenated monoterpenes     | 97.20 |
Hydrocarbons monoterpenes   | 0.76  |
Hydrocarbons sesquiterpenes | 0.13  |
Aliphatic compounds         | 0.37  |
**Tableau V:** Chemical composition of *Eucalyptus citriodora* Hook. essential oil.

![Chemical structure of Eucalyptus citriodora essential oil](image)

**Figure 5:** Chemical structures of the main constituents of *Eucalyptus citriodora* Hook. essential oils.

**Hemisynthesis of 2,4-dinitrophenylhydrazones:**

**Physical characterization:**

Table VI shows the results of the hemi-synthesis of 2,4-dinitrophenylhydrazones and their measured melting points. The reaction of 2,4-dinitrophenylhydrazine in the presence of sulfuric acid on the essential oils of *Cymbopogon citratus* and *Eucalyptus citriodora* gives rise to precipitates of orange and brown colors respectively. These colors are characteristic of 2,4-dinitrophenylhydrazone derivatives.

The essential oils of *Cymbopogon citratus* and *Eucalyptus citriodora* contain a varied range of constituents. 2,4-dinitrophenylhydrazones are formed after three (3) to five (5) minutes, the kinetics are slow so the extraction is also slow. Moreover, the yields of the hemi-synthesis of 2,4-dinitrophenylhydrazones obtained from these essential oils are low and respectively 20% and 37%. These low yields can be explained by the influence of the different constituents of essential oils during the reaction. In fact, the presence of the different constituents in essential oils changes the speed of extraction, resulting in slow kinetics. This slowing down means that there is competition or hindrance between the compound to be extracted and the other constituents of the mixture. This Competition is linked to steric and electronic effects.

Furthermore, the melting points of the hydrazones of the essential oils of *Cymbopogon citratus* and *Eucalyptus citriodora* are 114 °C and 79 °C, respectively. These melting points are approximate to those in the literature (Rappoport, 1967) and correspond respectively to those of geranial and citronellal.

**Tableau VI:-** Yields and physical properties of the various 2,4-dinitrophenylhydrazones synthesized.

| Compounds of essential oils converted to 2,4-dinitrophenylhydrazones | Aspect | Colour | yield (%) | Pf measured (°C) | Pf of literature (°C) |
|---------------------------------------------------------------|--------|--------|----------|-----------------|----------------------|
| *Cymbopogon citratus* (citral)                               | Precipitate | Orange | 20        | 114             | 96-116               |
| *Eucalyptus citriodora* (Citronellal)                        | Precipitate | Brown  | 37        | 79              | 78                   |

**Characterization by UV-visible spectrophotometry:**

The maximum wavelengths of geranial and citronellal 2,4-dinitrophenylhydrazones derived from essential oils of *Cymbopogon citratus* and *Eucalyptus citriodora* respectively of 390 nm and 370 nm were recorded (Table VII). These values are characteristic of the C=N chromophore of 2,4-dinitrophenylhydrazones, the wavelength of which at absorption maximum is (λmax = 360-370 nm) (Zhou & Mopper, 1990; Pötter et al., 1997; Levart & Veber, 2001).

**Tableau VII:-** Maximum absorption wavelengths of geranial and citronellal 2,4-dinitrophenylhydrazones.

| 2,4-Dinitrophenylhydrazone derivatives | λmax (nm) |
|---------------------------------------|-----------|
|                                       | 390       |
Cymbopogon citratus (Géraniel 2,4-dinitrophénylhydrazone):  
The UV-visible absorption spectrum of geranial 2,4-dinitrophenylhydrazone from the essential oil of *Cymbopogon citratus* plotted in (Figure 6) shows three main bands:
1. A low intensity band at 247 nm. This band is attributable to the $\pi\rightarrow\pi^*$ transition of the C=C group of the ethylenic group;
2. A low intensity band at 298 nm. This band corresponds to the transition $\rightarrow\sigma^*$ relating to the aniline aromatic system;
3. Another not very intense band at 390 nm relating to the $n\rightarrow\pi^*$ transition characteristic of the C=N group of hydrazone.

![Figure 6](image_url)

*Figure 6:*- UV-visible spectrum of geranial 2,4-dinitrophenylhydrazone from the essential oil of *Cymbopogon citratus* (DC.) Stapf.

A bathochromic effect (increase in the absorption band) is observed in the spectrum of the 2,4-dinitrophenylhydrazone geranial for the 390 nm band, a band which would be between 360-370 nm (Zhou
corresponding to the maximum absorption wavelength of the C=N group of 2,4-dinitrophenylhydrazone. This bathochromic effect could be explained by the steric and electronic effects observed within this molecule.

**Eucalyptus citriodora (citronellal 2,4-dinitrophénylhydrazone):**

Le spectre UV-visible du citronellal 2,4-dinitrophénylhydrazone issu de l’huile essentielle d’*Eucalyptus citriodora*montre trois bandes essentielles (figure 7) :

1. Une bande fine d’intensité moyenne à 259 nm correspondant à la transition π→π* du groupement (C=C) du système éthylénique ;
2. Une autre bande d’intensité moyenne à 287 nm attribuable à la transition n→σ* relative au système aromatique anilinique ;
3. Une bande très intense à 370 nm. Cette bande est caractéristique de la transition n→π* du groupement C=N de l’hydrazone.

![Figure 7](image)

**Figure 7:**- UV-visible spectrum of citronellal 2,4-dinitrophenylhydrazone from the essential oil of *Eucalyptus citriodora* Hook.

The different absorption bands for geranial and citronellal 2,4-dinitrophenylhydrazones, as well as their chromophores, are shown in Table VIII.
Tableau VIII: Bandes d’absorption UV-visibles du géranal et du citronellal 2,4-dinitrophénylhydrazones.

| 2,4 Dinitrophénylhydrazones derivatives | Bande d’absorption λ (nm) | Transition et Chromophore | Groupement |
|------------------------------------------|---------------------------|---------------------------|------------|
| Géranal 2,4-dinitrophénylhydrazone       | 247 Very low intensity    | π→π* (C=C)                | Ethylenique System |
|                                          | 298 Little intense        | n→σ* (C-NH-)              | Aromatic system aniline |
|                                          | 390 Little intense        | n→π* (C=N)                | Hydrazone    |
| Citronellal 2,4-dinitrophénylhydrazone  | 259 Thin, medium intensity| π→π* (C=C)                | Ethylenique System |
|                                          | 287 Medium intensity      | n→σ* (C-NH-)              | Aromatic system aniline |
|                                          | 0 Very intense            | n→π* (C=N)                | Hydrazone    |

Dinitrophénylhydrazine:
The UV-visible spectrum of 2,4-dinitrophénylhydrazine shown in (Figure 8) shows three main bands at 346 nm, 360 nm and at 377 nm due to the chromophoric groups C-N and NO₂ substituted at the aromatic nucleus.

Figure 8: UV-visible spectrum of 2,4-dinitrophénylhydrazine.
Conclusion:
Geranial (citral a) and citronellal 2,4-dinitrophenylhydrazones were hemi-synthesized by a simple, easy method from the essential oils of *Cymbopogon citratus* (DC.) Stapf and *Eucalyptus citriodora* (Hook.) Respectively with conversion rate (yields) of 20% and 37 % respectively, in a short time (three to five minutes). Analysis of geranial and citronellal 2,4-dinitrophenylhydrazones by UV-visible spectrophotometry showed maximum absorption wavelengths of 390 nm and 370, respectively. The UV-visible spectrophotometric method employed for the determination of these hydrazones is convenient, fast and simple. The hemi-synthesized hydrazones could be useful in the pharmaceutical, perfume and cosmetic industries. Indeed, citral and citronellal hydrazones are known for their olfactory functions (Kaushik et al., 2016) which orient their uses in cosmetics and perfumery as hydrogels and in biomedicine (Kölmel and Kool, 2017; Xu and Liu, 2019).

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