

Full Length Research Paper

Phytochemical study and anti-radical activity of extracts from the oil seeds of *Desbordesia glaucescens* (Engl.) Tiegh. from Gabon

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The report focused on the extraction of oilseeds of *Desbordesia glaucescens* (Engl.) Tiegh. from Gabon as well as on the phytochemical study and evaluation of the anti-free radical activity of the extracts obtained. The extraction was carried out by cold maceration with solvents of increasing polarities: hexane, trichloroethylene, acetone, ethanol and distilled water. The anti-free radical activity was measured by scavenging the free radical cation of 2,2'-azinobis [3-ethylbenzothiazolin-6-sulfonic acid] (ABTS • +) with gallic acid as the standard antioxidant. Total extraction yields were in the order of 82.31%. Phytochemical tests demonstrated the presence of secondary metabolites of alkaloids, tannins, polyphenolstypes, reducing compounds, free anthracene derivatives, anthraquinones, total sugars, coumarins, free quinones, sterols and terpenes, carotenoids, flavonoids, cardiac glycosides, mucilages, saponins and leucoanthocyanins. The results of the anti-free radical activity showed that the polar extracts were much more anti-free of the free radicals than the non-polar extracts. The aqueous extract was the most active with an IC₅₀ of 10 µg. mL⁻¹, followed by ethanolic extract with IC₅₀ of 14 µg. mL⁻¹ and acetone extract with IC₅₀ of 150 µg. mL⁻¹. Cyclohexane and trichlorethylene extracts were more or less inactive. Gallic acid, the standard antioxidant, showed an IC₅₀ of 0.37 µg. mL⁻¹.

Key words: *Desbordesia glaucescens*, oil seeds, extracts, phytochemical tests, anti-radical activity, ABTS test.

INTRODUCTION

The seeds or fruits of trees such as *Desbordesia glaucescens* (Engl.) Tiegh can be eaten as a main dish, condiment, or fortifier. They participate in the diversity and balance of the diet of populations or they can be

used in the form of drugs or cosmetic products (FAO, 2016).

Fats from oilseeds of trees have a wide range of applications and are of great interest as a potential

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source of natural bioactive molecules. Tropical fats are a major economic issue. In industry, for example, they could present themselves as a specific alternative to petrochemicals. Certain species of the Congo Basin, such as *Irvingia gabonensis* and *Dacryodes edulis*, present undeniable advantages. Fatty acids such as palmitic acid, oleic acid, linoleic acid and stearic acid extracted from the oil of the pulp of *D. edulis* (Umoti et al., 1987; Silou et al., 2002; Ajayi et al., 2006; Kinkéla et al., 2006) confirm its nutritional value. It also attests to the exceptional quality of its oils which allow the body to cover its energy needs and fight against cardiovascular diseases (Silou et al., 2002; Nwosuagwu et al., 2009; Ajibesin, 2011). *D. edulis* fatty acids can be used in food and cosmetics (Tabuna et al., 2009).

The wild mango (*I. gabonensis*) has very oilseeds. Almond is high in fat and contains a polysaccharide which is a food thickener (Herzog et al., 1995). Its oil is involved in the composition of certain astringent remedies (Raponda Walker and Sillans, 1961). *I. gabonensis* is arguably the most effective herbal medicine in helping to restore leptin sensitivity and neutralise the mechanisms responsible for the build-up of body fat. It is a slimming food supplement (Ngondi et al., 2009). The oil extracted from almonds is used in pharmaceutical and cosmetic preparations (European Patent, 1998).

D. glaucescens is a large tree widespread in Cameroon, Congo, Gabon and Equatorial Guinea. In Gabon, the crushed seeds of *D. glaucescens* are used to make a "loaf" similar to *I. gabonensis* (Raponda Walker and Sillans, 1961). However, the seeds of this plant have not been the subject of many studies for its potential for food, cosmetic, pharmacological or as antioxidant compounds. In fact, in humans, the oxidative damage to DNA, lipids and proteins are associated with certain chronic diseases such as cardiovascular diseases, certain cancers, diabetes, inflammatory diseases, Alzheimer's disease and other neurodegenerative diseases, as well as the aging process (Choi et al., 2018; Klaunig 2018; Luc et al., 2020; Tonnie and Trushina, 2017; Kozakiewicz et al., 2019). An antioxidant could more or less help prevent the onset of these pathologies. The present work was set up to assess the phytochemical components of extracts from the oil seeds of *D. glaucescens* (Engl.) Tiegh. from Gabon and the evaluation of their anti-radical activity for use in remedying the effects of oxidative stress in humans.

MATERIALS AND METHODS

Purchase of chemicals

2,2'-Azinobis [3-ethylbenzothiazoline-6-sulfonic acid] (ABTS), gallic acid, potassium persulfate ($K_2S_2O_8$) and hydrated sodium dihydrogen phosphate were purchased from Sigma-Aldrich (Saint - Quentin Fallavier, France). All these products were required for analysis. Concentrated sulfuric acid (95-97%), cyclohexane, trichlorethylene, acetone, absolute ethanol, chloroform, isoamyl

alcohol, acetic anhydride, iron perchloride, magnesium shavings, chloroform, hydrochloric acid, Fehling's liquor, Dragendorff's reagent were also purchased from Sigma-Aldrich, Carlo Erba or Prolabo and used without further purification. Distilled water was obtained from Chimie Gabon. Molish's reagent, solutions of 1% iron perchloride, 2% ferric chloride, 1% sodium hydroxide, 10% and 25% ammoniac in water and hydrochloric alcohol were prepared in the laboratory.

Plant material

The seeds of *D. glaucescens* (Engl.) Tiegh. (Myristicaceae) were collected in January 2021 from Sibang Herbarium of IPHAMETRA (Libreville-Gabon) and then sent to the laboratory of the Pharmacopoeia and Traditional Medicine Institute (IPHAMETRA) where they were dried in the sun for several days and kept in the oven at 35°C until the time of the tests.

Extraction method by maceration

The successive extraction by maceration of the seed powders extracted from the fruits of *D. glaucescens* (Engl) was adopted using a Retsch-type grinder, with Iphamétra, using solvents of increasing polarities: cyclohexane, trichlorethylene, acetone, ethanol and distilled water. Eighty grammes of seed powder were introduced into glass Erlenmeyer flask containing 400 mL of solvent. The Erlenmeyer is then closed with a rubber stopper covered with aluminium foil. The mixtures were subsequently placed under stirring at room temperature on a PIERRON type stirrer for 24 h. After 24 h, the mixtures were separated by vacuum filtration with a Whatman No. 4 filter in a Buchner type funnel.

For aqueous filtrates, water was evaporated by lyophilization. The organic solvent extractions were evaporated in a pre-weighed flask in a rotary evaporator, in a 40°C bath and then placed in an oven at 40°C until a constant mass was obtained. The extracts were stored in the refrigerator in closed bottles and covered with aluminium foil for the next tests. The percentage of extractables relative to the initial mass of seed powders used was determined using the following equation:

$$R(\%) = \frac{M_{ext}}{M_{éch}} \times 100$$

where R: yield of extracts in%; M_{ext}: mass of the extract after evaporation or lyophilization in grammes; M_{éch}: anhydrous mass of the seed powder sample in grammes.

Phytochemical screening

The reagents used to carry out the phytochemical screening of the extracts were prepared according to the protocols described by Houghton and Raman (1998), Akinjogunla et al. (2010) and Badiaga (2011). All the different tests were carried out in triplicate.

For alkaloids, 2 mL of the extract was placed in a test tube and then a few drops of Dragendorff's reagent solution were added. The appearance of a red-orange precipitate indicated the presence of alkaloids (N'guessan, 2007).

For polyphenols, 2 mL of the extract were placed in a test tube, then a few drops of the 2% ethanolic ferric chloride solution were added. The appearance of a blue-blackish colour indicated the presence of polyphenols (N'guessan, 2007).

Sterols and triterpenes were determined by placing 1 mL of the acetic anhydride which is added to 2 mL of each extract. 1 mL of concentrated H₂SO₄ (sulfuric acid) is then poured into tubes, this is

the reaction of Libermann-Buchard. The appearance of a purple colour and colouring of the supernatant blue or purple green indicates the presence of sterols or triterpenes, respectively (Nzé Kamsi, 2020).

The presence of tannins was determined by adding to 1 mL of extract, 1 mL of distilled water and 1 to 2 drops of FeCl₃ solution (iron (III) chloride) diluted to 1%. The appearance of a dark green colour indicated the presence of tannins (Bentabet Lasгаа, 2015; cited by Hamid, 2018).

For reducing compounds, 2 mL of the extract were placed in a test tube, followed by 2 mL of Fehling's liquor. The whole content was then poured into a boiling water bath for 8 min. The appearance of a brick red precipitate indicated the presence of reducing compounds (Bentabet Lasгаа, 2015; cited by Hamid, 2018).

For flavonoids, 1 mL of extract was introduced into a test tube, then 1 mL of hydrochloric acid was added, followed by 1 mL of isoamyl alcohol then a few shavings of magnesium. The appearance of a pinkish-orange colour indicated the presence of flavonoids (Harbone, 1988).

Saponosides were identified by placing 10 mL of each extract in a test tube which was shaken vigorously with a vortex for 15 s. The tube was left to stand for 15 min. The appearance of persistent foam indicated the presence of saponins (N'guessan, 2007).

For cardiac glycosides, 2 mL of chloroform were added to 1 mL of each extract. The appearance of a reddish-brown colour after adding a few drops of concentrate H₂SO₄ (sulfuric acid) indicated the presence of cardiac glycosides (Yam, 2009).

The presence of free quinones was determined by adding a few drops of 1% NaOH (sodium hydroxide) to 1 mL of each extract. The appearance of a colour turning yellow red or purple indicated the presence of free quinones (Oloyede, 2005).

For anthraquinones, to 2 mL of each extract was added 1 mL of 10% NH₄OH. After shaking, the appearance of a purple colour indicated a positive test (Oloyede, 2005).

Leucoanthocyanins were identified by adding to 5 mL of each extract, 5 mL of hydrochloric alcohol and then a few drops of isoamyl alcohol. The mixture was heated for 2 min in a boiling water bath. The appearance of a red colouration indicated the presence of leucoanthocyanins (Fournet, 1979).

For carotenoids, to each 2 mL of the extract, 0.5 mL of concentrated H₂SO₄ (sulfuric acid) is added. The appearance of a blue colour that turned red indicated the presence of carotenoids (Nzé Kamsi, 2020).

In order to identify the mucilages, 1 mL of extract was introduced into a test tube, then 5 mL of absolute alcohol. Obtaining a fluffy precipitate after shaking indicated the presence of mucilage (Awor, 2003; cited by Hamid, 2018).

To determine the total sugars, to 1 g of each extract, 3 drops of Molish's reagent were added then 1 mL of concentrated H₂SO₄ (sulfuric acid). The appearance of a purple interphase indicated their presence (Feuya, 2015).

For coumarins, 1 mL of ammoniac diluted to 25% was added in 2 mL of extract. The whole content was heated in a water bath for 5 min and then a UV reading was taken at 365 nm. The appearance of an intense fluorescence in the tube showing either yellow, blue, blue-green, orange, purplish pink indicated the presence of coumarins (Awor, 2003; cited by Hamid, 2018).

Free anthracene derivatives were determined by adding 1 mL of ammoniac diluted to 25% to a 1 mL of extract in a test tube. After stirring, the appearance of a more or less red colour indicated their presence (Awor, 2003; cited by Hamid, 2018).

Anti-radical activity

The anti-free radical activity was determined by UV spectrophotometry using a V-200 spectrophotometer (BOECO, Germany).

The optical density was read at 734 nm recording the maximum absorption wavelength of the radical cation ABTS^{•+}.

Preparation of "reference antioxidant" gallic acid solutions

Gallic acid (3,4,5-trihydroxybenzoic acid) is an aromatic organic compound, used as a reference anti-free radical compound. Ten working solutions, in decreasing concentrations, ranging from 0.94 to 0.094 µg/mL, were prepared by diluting gallic acid in distilled water.

Preparation of seed solutions of *D. glaucescens* (Engl.) Van Tiegh

Ten solutions of increasing concentrations ranging from 2.5 to 200 µg/mL of different *Desbordesia* extracts were prepared by dissolving the powder in the extraction solvent.

Measurement of anti-radical activity

The principle of the test for measuring the anti-radical activity by the ABTS method was based on the decrease in the absorbance at 734 nm of the radical cation ABTS^{•+} (blue-green colouration) in the presence of a potentially anti-compound radical which reduced the cation radical. The reduction in the radical form of ABTS^{•+} led to a discolouration of the solution. The radical ion ABTS^{•+} was obtained by reacting the ABTS molecule (7 mM) with potassium persulfate (2.45 mM), in distilled water for 16 h at room temperature and protected from light.

The ABTS^{•+} solution obtained was diluted with sodium phosphate buffer (5 mM, pH = 7.4), in order to obtain a stock solution having an initial absorbance value at 734 nm between 0.65 and 0.70. The radical cation (ABTS^{•+}) was stable for more than 2 days when stored at room temperature and protected from light. All the assays were carried out three times and the anti-free radical activity was calculated according to the following formula:

$$\text{Anti-free radical activity (\%)} = [1 - (Ar - Ab) / (Ai - Ab)] \times 100$$

where Ar = remaining activity of ABTS^{•+}, Ai = initial activity of ABTS^{•+} and Ab = white activity.

In fact, the reduction of the ABTS^{•+} radical cation therefore amounted to determining the anti-free radical activity and in total, the antioxidant properties of *Desbordesia* extracts compared to the antioxidant properties of gallic acid (standard). The anti-free radical activity was determined by UV spectrophotometry in cuvettes with an optical path of 1 cm (reaction volume of 2 mL). The incubation time was 6 min (N'negue et al., 2020).

RESULTS AND DISCUSSION

Extraction yields

The results of the extractable contents of *Desbordesia* oil seeds presented in Table 1 indicate that the extractable levels vary from solvent to solvent. The cyclohexane extraction rate is the highest with 47.4% followed by the trichlorethylene extraction rate with 19.8%. On the other hand, the lowest yields of extracts are obtained with ethanol with 5.46% followed by acetone with 5.32 and water with 4.33%. The overall extract rate of *Desbordesia* seeds is 82.31%.

Table 1. Result of the extract rates of *Desbordesia* almonds obtained by maceration.

Solvent	Extraction rate (%)
	<i>Desbordesia</i>
Cyclohexane	47.4±0.6
Trichloroéthylène	19.8±1.7
Acetone	5.32±0.6
Ethanol	5.46±0.8
Distilled water	4.33±0.9
Total	82.31

Rate of extracts (average of three tests ± standard deviation)
Sources: (Medza M'Elia, 2022)

The results obtained indicate that cyclohexane, the first solvent used during the successive extraction of *Desbordesia* seeds and the least polar, mainly extracts containing liposoluble substances such as oils, fats and terpenes. It thus contains large fractions of fat and therefore a high yield of 47.4%. It is followed by a nonpolar solvent, trichlorethylene with 19.8% which also extracts the rest of the fat from the oil seeds of *Desbordesia*. Since the seed powder is largely de-oiled, the polar solvents solubilise the remainder of secondary metabolites such as polyphenols. The sum of the extracts with each solvent gives an idea of the overall extract content of the seeds. Thus, the overall extract rate of *Desbordesia* seeds is 82.31%.

Silou (2014) studied 130 samples of oils and fats extracted from 77 species of the Congo Basin constituting 35 botanical families and divided them into three classes of equal amplitude between 15 and 75% fat content. Plants with a low fat content have a rate between 15 and 35%; those with an average fat content have a rate of between 35 and 55% and finally plants with a high fat content have a rate of between 55 and 75%. In view of these percentages and from the figures recorded from the present study it is clear that *Desbordesia* is a highly oleaginous plants.

Phytochemical tests

The results of the phytochemical tests are presented in Table 2. The alkaloids were present in all the extracts. Polyphenols were abundant in acetone, ethanolic and aqueous extracts but absent in cyclohexane and trichlorethylene extracts. Leucoanthocyanins were moderately present in the aqueous extracts and absent in the rest of the extracts. Carotenoids were moderately present in the cyclohexane extracts, weakly in the trichlorethylene extract and absent in the other extracts.

Tannins were abundant in ethanolic and aqueous extracts, moderately present in acetone extract, weakly present in cyclohexane and absent in trichloroethylene

extract. Reducing compounds present in acetone, aqueous and cyclohexane extracts, but absent in the trichlorethylene extract. Flavonoids were abundant in the aqueous extract, moderately present in the ethanolic extract, weakly present in the cyclohexane and acetone extract but absent in the trichlorethylene extract. Saponins were weakly present in the aqueous extract and absent in the rest of the extracts.

Anthraquinones were present in the aqueous extract and absent in the rest of the extracts. Cardiac glycosides heavily present in the aqueous extract and absent in the rest of the extracts. The free quinones were abundant in acetone, ethanolic, aqueous extracts and weakly present in the cyclohexane and trichlorethylene extracts.

Mucilages heavily present in the cyclohexane extract and absent in the rest of the extracts. Total sugars heavily present in the aqueous extract, very weakly present in the cyclohexane extract and absent in the rest of the extracts. Sterols and triterpenes were also heavily present in the cyclohexane extract, weakly present in the trichlorethylene and acetone extracts and absent in the ethanolic and aqueous extracts.

Coumarins were very abundant in acetone and ethanolic extracts, moderately present in cyclohexane and trichlorethylene extracts and absent in the aqueous extract. Anthracene derivatives heavily present in the aqueous extract, moderately present in the ethanolic extract, very weakly present in the cyclohexane extract and absent in the trichlorethylene and acetone extracts.

The phytochemical tests carried out on the seeds of *Desbordesia* show the presence of alkaloids, tannins, polyphenols, reducing compounds, free anthracene derivatives, anthraquinones, total sugars, coumarins, free quinones, sterols and terpenes, carotenoids, flavonoids, cardiac glycosides, mucilages, saponins and leucoanthocyanins. These compounds possess therapeutic and preventive properties against several diseases, which support the use of *Desbordesia* oil seeds in traditional medicine in the treatment of several pathologies as reported by Kirsal et al. (1999). For example, polyphenols is one of the compounds extracted

Table 2. Results of the phytochemical tests the extract of *Desbordesia*.

Compounds	Solvents				
	CH	TCE	Acetone	Ethanol	Distilled water
Alkaloïdes	+++	+++	+++	+++	+++
Polyphénols	-	-	+++	+++	+++
Leucoanthocyanins	-	-	-	-	++
Caroténoïdes	++	+	-	-	-
Tannins	+	-	++	+++	+++
Reducing compounds	+++	-	+++	++	+++
Flavonoïdes	+	-	+	++	+++
Saponines	-	-	-	-	+
Anthraquinones	-	-	-	-	+++
Cardiac glycosides	++	-	-	-	+++
Free quinones	+	+	+++	+++	+++
Mucilages	+++	-	-	-	-
Total sugars	+	-	-	-	+++
Sterols and triterpenes	+++	+	+	-	-
Coumarins	++	++	+++	+++	-
Free anthracene derivatives	+	-	-	++	+++

Colouring: +++: very intense, ++: moderately intense, +: not very intense, -: absence, TCE: Trichloroethylene, CH: Cyclohexane.
Sources: (Medza M'Ella, 2022)

from *Desbordesia* oil seeds in the present study are believed to have a significant effect on pathologies such as cancer or cardiovascular disease (Krisa et al., 1999). Their numerous pharmacological properties *in vitro* are reported to be linked to their antioxidant properties (Lucrecia et al., 2006). Polyphenols are also known to be active on viruses and bacteria (Dubois et al., 1986; Bruneton, 1999). In the present study, the seeds of *Desbordesia* show the presence of alkaloids in all extracts of cyclohexane, trichloroethylene, acetone, ethanol and water and these compounds are sought after for their physiological effects and their pharmacological activities which are exerted in various fields. They also play the role of antibiotics (Badiaga, 2011).

Cardiac glycosides shown in the phytochemical tests of *Desbordesia* seeds can be major drugs for heart failure. They exercise their activity on the heart on several levels; contraction forces, frequency and conductivity (Bruneton, 2009), as these effects are reflected in the electrocardiographic changes. The other compounds, sterols and triterpene alcohols also extracted from *Desbordesia* in this study have anti-inflammatory, anti-diabetic, anti-cancer, anti-diarrheal, and anti-viral activities (Venkata et al., 2012).

In addition, mucilages have very many applications like in the food sector, they are used as a texturizing agent and in the cosmetic and pharmaceutical fields, they can be used as a softener, antioxidant, emollient and soothing (Fedeniuk and Biliaderis, 1994; Oomah and Sitter, 2009). A strong presence of coumarins was detected in the acetone and ethanolic extracts and an average presence

in the extracts of cyclohexane and trichloroethylene. These extracts may be of interest in pharmacology in the treatment of *psoriasis* and vitigo, or have a favourable action on disorders of cerebral senescence (Bruneton, 1987).

Anti-radical activity

Anti-free radical activity of gallic acid depending on the concentration

The anti-radical activity of the standard antioxidant "gallic acid" increased linearly with its concentration (Figure 1). The value of the IC₅₀ which is the concentration necessary for the reduction of 50% of the anti-radical activity of gallic acid deduced from the curve is 0.37 µg/mL (2 µM). The antioxidant activity of gallic acid which is a strongly antioxidant synthetic molecule, validates the method chosen in the present work.

Anti-radical activity of extracts of *D. glaucescens*

Evaluation of the anti-radical activity of the aqueous extract: From the results obtained (Figure 2A), the anti-radical activity of the aqueous extract increased sharply with concentration. Indeed, it increased from 17.19 ± 1.48% for a concentration of 2.5 µg.mL⁻¹ at 52.68 ± 2.26% for a concentration of 10 µg.mL⁻¹ and at approximately 85% for a concentration of 20 µg.mL⁻¹ at

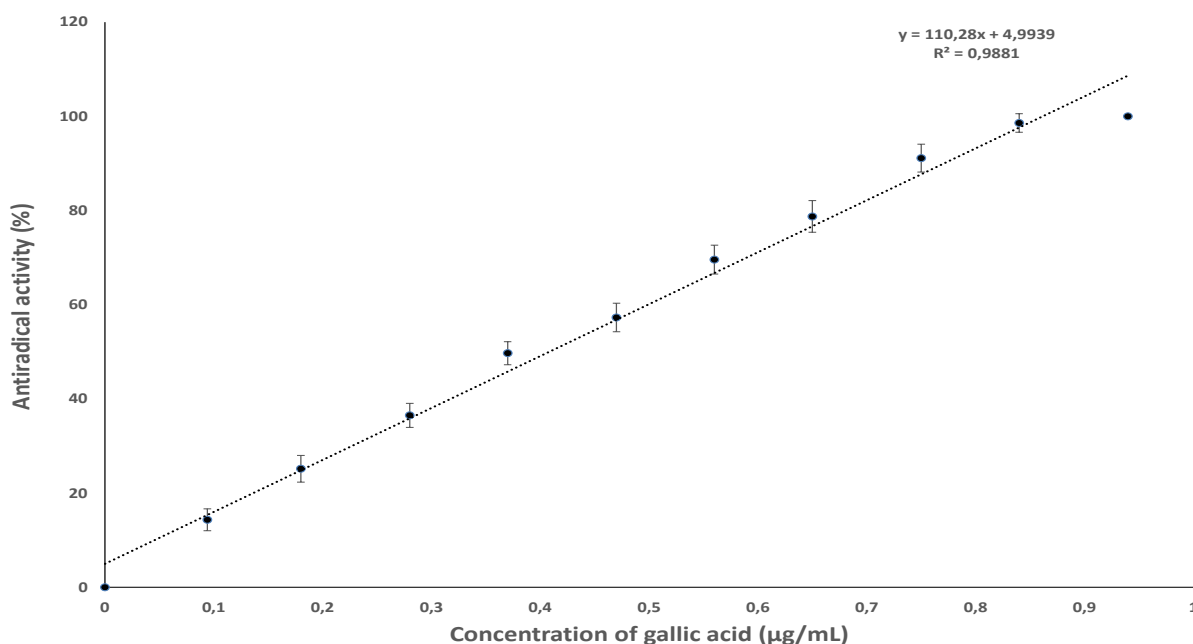


Figure 1. Anti-radical activity as a function of the concentration of gallic acid after 6 min of incubation. The proportion $\text{ABTS}^{\bullet+}$ transformed into ABTS^+ in the presence of gallic acid is calculated from the change in absorbance at 734 nm measured by spectrophotometry. The equation on the right is: $y = 110.28x + 4.9$ ($R^2 = 0.98$); $n = 3$. Sources: (Medza M'Ella, 2022)

the IC_{50} of $10 \mu\text{g}\cdot\text{mL}^{-1}$. From these results, it can be deduced that the aqueous extract of *Desbordesia* has a strong anti-radical activity.

Evaluation of the anti-radical activity of the ethanolic extract: The results presented in Figure 2B show an anti-radical activity increasing with the concentration of ethanolic extract of *Desbordesia*. The anti-radical activity was $18.99 \pm 0.99\%$ for a concentration of $2.5 \mu\text{g}\cdot\text{mL}^{-1}$ and $85.15 \pm 1.48\%$ for a concentration of $50 \mu\text{g}\cdot\text{mL}^{-1}$ in ethanolic extract at the IC_{50} of $14 \mu\text{g}\cdot\text{mL}^{-1}$. The ethanolic extract should, therefore, have a slightly lower activity than that of the aqueous extract with $\text{IC}_{50} = 10 \mu\text{g}\cdot\text{mL}^{-1}$.

Evaluation of the anti-radical activity of the acetone extract: The results presented in Figure 2C show a weakly increasing anti-radical activity with the concentration of acetone extract of *Desbordesia*. Indeed, it was $1.22 \pm 0.20\%$ for a concentration of $2.5 \mu\text{g}\cdot\text{mL}^{-1}$, only $21.18 \pm 1.08\%$ for a concentration of 25 and $54.11 \pm 1.75\%$ for a concentration of $200 \mu\text{g}\cdot\text{mL}^{-1}$ at IC_{50} $150 \mu\text{g}\cdot\text{mL}^{-1}$. Thus, the acetone extract is, therefore, less active than the aqueous and ethanolic extracts.

Evaluation of the anti-radical activity of the trichlorethylene extract: According to the results depicted in Figure 2D, the anti-radical activity of the trichlorethylene extract is very weak or nonexistent and changes very little with concentration. Indeed, it was

$0.466 \pm 0.13\%$ for a concentration of $2.5 \mu\text{g}\cdot\text{mL}^{-1}$; $2.13 \pm 0.19\%$ for a concentration of $50 \mu\text{g}\cdot\text{mL}^{-1}$ and $2.74 \pm 0.08\%$ for a concentration of $200 \mu\text{g}\cdot\text{mL}^{-1}$ with IC_{50} well above $200 \mu\text{g}\cdot\text{mL}^{-1}$. It can therefore be deduced from these results that the trichlorethylene extract is not anti-radical.

Evaluation of the anti-free radical activity of the cyclohexane extract: The percentage of anti-radical activity increased very little or not at all with the concentration of cyclohexane extract from *D. glaucescens* (Figure 2E). Indeed, it was $0.487 \pm 0.23\%$ for a concentration of $2.5 \mu\text{g}\cdot\text{mL}^{-1}$; $1.41 \pm 0.04\%$ for a concentration of $50 \mu\text{g}\cdot\text{mL}^{-1}$ and only $1.69 \pm 0.104\%$ for a concentration of $200 \mu\text{g}\cdot\text{mL}^{-1}$. The IC_{50} of the cyclohexane extract like that of the trichlorethylene extract would be well above $200 \mu\text{g}\cdot\text{mL}^{-1}$. Cyclohexane extract like trichlorethylene extract appears to lack anti-radical activity. The compounds responsible for this oxidizing activity are very little or not soluble in cyclohexane as in trichlorethylene, which are both nonpolar solvents.

The results of the evaluation of the anti-free radical activity of *Desbordesia* seed extracts show variation of the anti-radical activity with the mode of extraction. Indeed, according to the present results, polar extracts low in fat but rich in phenolic compounds have much higher anti-radical activities than non-polar oleaginous extracts. Maximum activity was obtained with the more

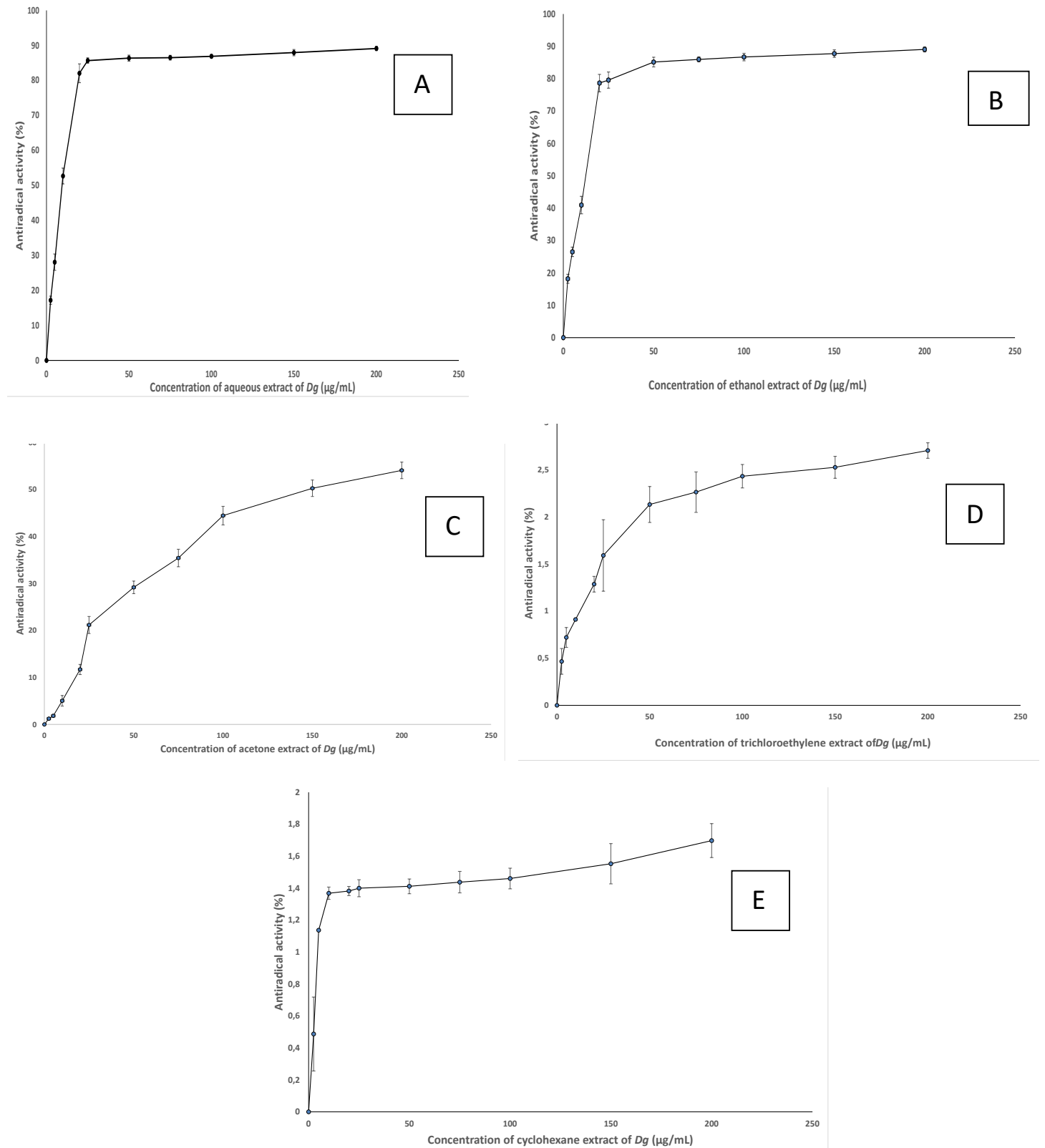


Figure 2. Anti-radical activity according to the concentration of aqueous extract (figure A), the concentration of ethanol extract (figure B), the concentration of acetone extract (figure C), the concentration of trichloroethylene extract (figure D), the concentration of cyclohexane extract (figure E) of *D. glaucescens* after 6 min of incubation. The proportion $ABTS^{\bullet+}$ transformed into $ABTS^+$ is calculated from the change in absorbance at 734 nm measured by spectrophotometry: $n = 3$. Sources: (Medza M'Ella, 2022)

polar extract, the aqueous extract, with an IC50 of 10 $\mu\text{g}\cdot\text{mL}^{-1}$, followed by the ethanolic extract with an IC50 of 14 $\mu\text{g}\cdot\text{mL}^{-1}$ and finally the acetone extract with an IC50 of 150 $\mu\text{g}\cdot\text{mL}^{-1}$. The non-polar "cyclohexane and trichlorethylene" extracts, which are rich in fat, have very low or even non-existent anti-radical activities.

These polar and non-polar activities of the extracts can be explained by the strong presence of polyphenols "antioxidant compounds" in the polar extracts and their absence in the non-polar extracts. Indeed, according to reports by several workers, polyphenolic compounds are capable of trapping free radicals, which explains their strong anti-free radical power (Biradar et al., 2016; Nga et al., 2017; Becker et al., 2019).

The phytochemical study of the extracts from the seeds of *Desbordesia* showed that leucoanthocyanins, anthraquinones and saponins were only present in the aqueous extract, flavonoids, polyphenols and tannins were very abundant in this extract, but these latter compounds are recognized in the literature as high level antioxidants due to their ability to scavenge free radicals such as singlet oxygen, superoxide free radicals and hydroxyl radicals (Anderson et al., 1996; Kawamura et al., 2011; Jaswir et al., 2011; Tremel and Smejkal, 2016).

However, in the ethanolic extract, there was a strong presence of tannins with an average amount of flavonoids. The acetonic extract is composed of a low level of flavonoids and an average level of tannins. The presence at a higher rate of phenolic compounds with antioxidant character in the aqueous extract might explain the greater anti-radical activity of this extract compared to the ethanolic and acetonic extracts. On the other hand, the presence in very low quantity or the absence of antioxidant compounds, namely; polyphenols, carotenoids, flavonoids and tannins (Khadrhi et al., 2012) in nonpolar extracts, like cyclohexane and trichlorethylene, might also explain the lack of anti-radical activity of these extracts.

The activity of polar extracts is comparable to that of gallic acid the "standard antioxidant". Indeed, the active principle responsible for the anti-radical activity representing only about 10% of the total compounds of the extract, the IC50s of 10 $\mu\text{g}\cdot\text{mL}^{-1}$ of the aqueous extract or of 14 $\mu\text{g}\cdot\text{mL}^{-1}$ of the ethanolic extract might be equivalent to IC50s of 1 $\mu\text{g}\cdot\text{mL}^{-1}$ or 1.4 $\mu\text{g}\cdot\text{mL}^{-1}$ of their respective active ingredients. That is, only 2.7 or 3.78 times higher than the IC50 of the reference antioxidant which is a compound pure chemical "gallic acid, IC50 = 0.37 $\mu\text{g}\cdot\text{mL}^{-1}$ ". Thus, the aqueous extract might, therefore, have a slightly weaker anti-free radical activity than that of gallic acid.

Conclusion

The results showed that the levels of extracts varied from solvent to solvent and that the levels of total extractables from oilseeds of *D. glaucescens* (Engl). Van Tiegh. Were

82.31%. This classifies *D. glaucescens* in the group of highly oilseed plants. The phytochemical tests carried out have shown that the seeds are rich in chemical compounds such as alkaloids, tannins, polyphenols, reducing compounds, free anthracene derivatives, anthraquinones, total sugars, coumarins, free quinones, sterols and terpenes, carotenoids, flavonoids, cardiac glycosides, mucilages, saponins and leucoanthocyanins.

Phytochemical screening of the various *Desbordesia* extracts showed that the aqueous extract was the richest in antioxidant phenolic compounds followed by the ethanolic extract then the acetone extract. Also, the maximum anti-radical activity was observed with the aqueous extract then with the ethanol and finally with the acetone extracts. On the other hand, the "cyclohexane and trichlorethylene" extracts rich in fat have very little or no activity.

A number of studies have revealed the important role that antioxidants play in the society. Extracts with strong anti-radical activity of *Desbordesia* such as aqueous and ethanolic extracts with antioxidant properties will, therefore, have preventive potentials in the fight against pathologies associated with oxidative stress. Such maladies like diabetes, cardiovascular diseases, aging, cancer, inflammation, neuronal or genetic diseases are presented with oxidative stress. Elsewhere, the polar extracts rich in antioxidants can be used in the food, cosmetic and pharmaceutical industries as natural antioxidants fighting against oxidation, and as sources of fat for non-polar extracts.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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