

Phytochemical Profile, Acute Toxicity, Antioxidant and Anti-inflammatory Activity of Hydroethanolic Extracts From *Odontonema strictum* (Nees) Kuntze (Acanthaceae) Root and Stem

ABSTRACT

Aims: Our study aimed to investigate phytochemical groups with antihypertensive potential, antioxidant and anti-inflammatory properties, and the safety of using stems and roots hydroethanolic extracts.

Place and Duration of Study: *Odontonema strictum* (Nees) Kuntze (Acanthaceae), roots and stems were harvested in June 2022 from the "Institut de Recherche en Sciences de la Santé / Centre National de la Recherche Scientifique et Technologique (IRSS/CNRST)" botanical garden (GPS coordinates N 12°22.161', W 001°29.088'), Ouagadougou (Burkina Faso). The experiments were conducted from July to December 2022 at Laboratoire de Recherche-Développement de Phyto-médicaments et Médicaments/IRSS/CNRST, Ouagadougou.

Methodology: Phytochemical screening by HPTLC and determining flavonoids and total polyphenols were carried out. The antioxidant activity was evaluated using ABTS, FRAP, DPPH, and LPO methods. The inhibitory activity of Phospholipase A2 and 15-lipoxygenase was determined. Finally, acute oral toxicity was carried out on female mice NMRI.

Results: The hydroethanolic extracts of *Odontonema strictum* root (HE_ROS) and stem (HE_SOS) contain tannins, sterols, triterpenes, flavonoids, and saponosides. HE_SOS gave the highest levels of flavonoids (23.69 ± 1.10 mg QE/g) and total phenolics (64.15 ± 4.02 mg TAE/g). The two hydroethanolic extracts had antioxidant activity, with HE_ROS being the best. However, these activities were lower than Trolox ($p < 0.05$). The extracts have a moderate inhibitory effect on 15-lipoxygenase and Phospholipase A2. Finally, HE_ROS and HE_SOS are practically non-toxic when administered once orally.

Conclusion: This study provided scientific data and could justify the use of *Odontonema strictum* in the treatment of hypertension.

Keywords: *Odontonema strictum*, Root, Stem, Antioxidant, Anti-inflammatory, Safety of use

1. INTRODUCTION

The pathophysiology of cardiovascular disease is multifactorial. It involves inflammation, oxidative stress, vascular dysfunction, and sympathetic system activation[1, 2]. To cope with these disorders, patients, in addition to modern medicines, turn to alternative medicine. For example, herbal medicines are steadily increasing due to greater adherence and acceptance in both developing and developed countries[3, 4]. Furthermore, the growing interest in alternative medicine is thought to be explained by the failure of conventional medicine or the search for new bioactive compounds for disease management[5]. Thus, ethnopharmacological evidence could be considered valuable hypotheses to support preclinical or clinical research in phytomedicines in the current context of developing new or alternative therapeutic agents from natural sources. Moreover, the only data available on the potential applications of plant species in phytotherapy are sometimes those provided by ethnopharmacology, given their limited use by indigenous populations[6, 7]. In addition, among the plants used to treat chronic conditions such as hypertension is *Odontonema strictum* (Nees) Kuntze (Acanthaceae), a decorative plant from Latin America. It is known to be used in alternative medicine to treat arterial hypertension[8, 9]. Using pharmacological tests, the authors reported that aqueous, alcoholic, and ethyl acetate extracts of the plant's leaves have antihypertensive/hypotensive properties *in vivo* and vasorelaxant properties *ex vivo* on the coronary arteries of mice, rats, and pigs[9, 10]. The extracts have also shown antioxidant properties [11, 12]. Phytochemically, flavonoids O-heterosides and C-heterosides have been isolated from the plant's leaves [8] and polyphenols such as verbascoside and isoverbascoside[13]. *Odontonema strictum* leaves, and flowers contain carbohydrates, saponins, flavonoids, sterol-terpenes, tannins, anthocyanins, β -Sitosterol, and Stigmasterol[10, 13-15]. Moreover, all the findings on the plant concern the leaves. Therefore, this study investigated phytochemical groups with antihypertensive potential, antioxidant and anti-inflammatory properties, and the safety of using stems and roots hydroethanolic extracts.

2. MATERIAL AND METHODS

2.1. Material

2.1.1. Chemicals and Reagents

Chloroform, Ethylacetate, Methanol, Hexane, formic acid, Dimethylsulfoxide (DMSO), NEU reagent, aluminum trichloride, ferric trichloride, iron chloride, Folin Ciocalteu reagent (FCR), sulphuric anhydride reagent, Liebermann-Burchard reagent, monobasic potassium phosphate, sodium phosphate dibasic, 15-lipoxygenase (EC 1.13.11.12), linoleic acid, potassium hexacyanoferrate, sodium bicarbonate, thiobarbituric acid (TBA), trichloroacetic acid (TCA), hydrogen peroxide solution, 2,2'-azino bis-[3-éthylbenzothiazoline-6-sulfonique] (ABTS), 2,2-diphenyl- β -picrylhydrazyl (DPPH), and potassium persulfate were purchased from Sigma-Aldrich (St. Louis, MO, USA). Quercetin, Gallic acid, Ascorbic acid, Trolox, Acetylsalicylic acid, Betamethasone, and Zileuton were supplied by Sigma Aldrich. Silica gel TLC plates F 254 grade were from Macherey-Nagel (Germany).

2.1.2. Plant Material

Odontonema strictum roots and stems were harvested in June 2022 from the "Institut de Recherche en Sciences de la Santé / Centre National de la Recherche Scientifique et Technologique (IRSS/CNRST)" botanical garden (GPS coordinates N 12°22.161', W 001°29.088'), Ouagadougou (Burkina Faso). The reference specimen (HNBU 8702), after identification of the plant, was

prepared and deposited at the "Département Environnement et Forêts (DEF)/CNRST," Ouagadougou, Burkina Faso. The collected samples were protected from sunlight and dust, dried in the open air, and ground using a mechanical grinder (Gladiator Est. 1931 Type BN 1 Mach. 404611083) to a powder. The roots and stem powder obtained were used to prepare the study extracts.

2.1.3. Experimental Animals

Female NMRI (Naval Medicinal Research Institute) mice with average weights of 27 ± 2 g from the animal house of the "Institut de Recherche en Sciences de la Santé / Centre National de la Recherche Scientifique et Technologique (IRSS/CNRST), Burkina Faso." They were reared in plastic cages containing wood shavings at a temperature of 21-23 °C with a relative humidity of 55-60% and subjected to light (12/24 h) according to the rearing conditions of these species. Standard laboratory pellets enriched with proteins (29%) and water were provided for satiation to mice [16].

2.2. Methods

2.2.1. Phytochemical Study

2.2.1.1. Preparation of Hydroethanolic Extract

Extraction was performed using the maceration exhaustion technique described by Nitiéma et al. [17]. Briefly, for 24 h at room temperature, 200 g of each plant powder was macerated in 1000 mL of 80% ethanol (Ethanol 96%/Water; 80/20; v/v). After 24 h, the mixture was filtered through a fine mesh nylon cloth and centrifuged at 2000 rpm for 5 min. Each residual pomace was reworked twice under the same conditions with 80% ethanol. The filtrates obtained were concentrated in a rotavapor (electronic microprocessor controller CPS ventilated type) under reduced pressure at a constant temperature of 60 °C and then frozen and lyophilized. The hydroethanolic extracts of *Odontonema strictum* root (HE_ROS) and *Odontonema strictum* stem (HE_SOS) were then recovered and stored in a hermetically sealed plastic bottle protected from light and humidity for the various tests.

2.2.1.2. Phytochemical screening by High-Performance Thin-Layer Chromatography

High-performance thin-layer chromatography (HPTLC) was used to detect saponosides, flavonoids, sterol-triterpenes, and tannins in the two extracts. HPTLC was carried out on chromatoplates (60 F₂₅₄, 10 x 5 cm, glass support 10 x 20 cm, Merck) [18]. Approximately 20 µL of each extract was streaked with a semi-automatic sample dispenser (CAMAG, Linomat 5, Switzerland) along the baseline 0.8 cm from the bottom edge of the plate. After deposition and drying, the plates were placed in a tank containing eluent previously saturated (20 x 10 cm, saturation time: 30 min). The solvent system used depended on the metabolite to be identified: Ethyl acetate/formic acid/H₂O (18/2/4/2/1 v/v/v/v) for tannins; Ethyl acetate/formic acid/H₂O, (8/2/1 v/v/v/v) for flavonoids; Hexane/ethyl acetate/methanol (10/5/5 v/v/v) for saponosides; Ethyl acetate/hexane (8/2 v/v) for Sterol-triterpenes. After migration over 80 mm in length, the plates were dried, and Neu reagent for flavonoids, Sulphuric anisaldehyde reagent for saponosides, Liebermann-Burchard reagent for Sterol-triterpenes and 5% of FeCl₃ for tannins revealed the chromatographic profiles. The phytochemical profiles of the two were then observed under visible light (tannins) and at UV wavelengths of 366 nm.

2.2.1.3. Determination of Total Phenolic Compounds

The total phenolic content of HE_ROS and HE_SOS was determined using the Folin-Ciocalteu Reagent (FCR) [19]. Gallic acid, the reference compound, was used to construct the standard curve. Briefly, 25 µL of sample at a concentration of 1 mg/mL was mixed with 125 µL of FCR. One hundred (100) µL of 7.5% w/v sodium carbonate solution was added to the mixture. Absorbance at 760 nm was measured using a microplate reader (Spectro UV, Epoch Biotek, USA) after one hour's incubation. Results were expressed as mg gallic acid equivalent (GAE)/g dry extract.

2.2.1.4. Determination of Flavonoid Compound

The total flavonoid content of HE_ROS and HE_SOS was assessed using an aluminum trichloride reagent [19]. A standard calibration curve was plotted with quercetin as the reference. Briefly, 100 µL of each extract (1 mg/mL) was mixed with 100 µL of a 2% w/v aluminum trichloride solution. Absorbance at 415 nm was measured using a mass spectrophotometer (Epoch Biotek, USA) after 10 min's incubation. Results were expressed as mg quercetin equivalent (QE)/g dry extract of *Odontonema strictum*.

2.2.2. Assessment of Antioxidant Properties

2.2.2.1. Ferric Reducing Antioxidant Power (FRAP) Assay

The FRAP assay was performed on HE_ROS and HE_SOS, and Trolox as previously described [20]. The mixture of 1.25 mL potassium hexacyanoferrate aqueous solution (1%) and 0.5 mL samples with 1.25 mL phosphate buffer was incubated at 50°C for 30 min. Next, 1.25 mL of trichloroacetic acid (10%) was added and centrifuged at 3000×g for 10 min. FeCl₃ solution (0.125 mL, 0.1%) and distilled water (0.625 mL) were added to the supernatant (0.625 mL), and absorbance was measured at 700 nm using a spectrophotometer (Agilent, Santa Clara, CA) equipped with ChemStation UV-visible software. The reference substance Trolox was used to plot the calibration curve. The FRAP activity of the samples (HE_ROS and HE_SOS) was expressed as mmol Trolox equivalent/gram dry extract.

2.2.2.2. DPPH• Assay

Free radical scavenging activity by hydroethanolic extracts of *Odontonema strictum* root and stem and Trolox was performed using 2,2-diphenyl-1-picrylhydrazyl (DPPH) [21]. Briefly, after 30 min of incubation in the dark at room temperature, the absorbance of 10 µL of samples and Trolox added to 200 µL of DPPH (0.04 mg/mL) was measured at 490 nm using a Bio-Rad spectrophotometer (model 680, Japan). The result was expressed as antioxidant capacity equivalent to Trolox. As a function of sample concentration, a DPPH•-inhibition percentage curve was plotted. The inhibition (%) of the DPPH radical was calculated using the following formula: Inhibition (%) = [(Ac - Ae)/Ac] × 100; Ae and Ac represent, respectively, the absorbances of the extract/ascorbic acid and the control (DPPH solution without sample). The concentration required to inhibit 50% of DPPH (IC₅₀) was determined on the curve.

Anti-radical power (ARP) was determined by the formula: ARP = 1/IC₅₀; ARP: Anti Radical Power; IC₅₀: 50% inhibitory concentration expressed in µg/mL

2.2.2.3. ABTS•⁺ Assay

The ABTS free radical scavenging activity of HE_ROS and HE_SOS and Trolox was assessed using the procedure described previously [19]. A mass of 19.2 mg of ABTS was dissolved in 5 mL of distilled water. A mass of 3.312 mg potassium persulphate was added to the ABTS solution

at 3.84 mg/mL. The solution was left for 16 h in the dark at room temperature before use, after adding the potassium persulphate. On the day of the experiment, 4.5 mL of the mixture was diluted in 220 mL of absolute ethanol. The range of 8 dilutions to be tested was prepared from the parent concentration of the samples (1 mg/mL). On a 96-well microplate, 200 μ L of ABTS solution mixed with 20 μ L of the extract or reference was added to each well. After incubation at 25 °C for 30 min, absorbances at 415 nm were read against a blank using an Agilent 8453 spectrophotometer with ChemStation UV-visible software. Measurements were performed in triplicate. The percentage inhibition of absorbance at 415 nm was calculated according to the formula:

$$\% \text{ Inhibition} = [(A_0 - A) / A_0] \times 100$$

A_0 is the absorbance of the control; A is the absorbance of the sample.

The absorbance inhibition curve as a function of the concentration of HE_ROS, HE_SOS, or Trolox was constructed to determine the 50% inhibitory concentration (IC_{50}). Anti-radical power (ARP) was determined using the formula: $ARP = (1/IC_{50})$; ARP: Anti-radical power; IC_{50} : 50% inhibitory concentration expressed in μ g/mL.

2.2.2.4. Lipid Peroxidation Inhibition (LPO) Assay

The lipid peroxidation activity of Wistar rat liver was determined using 2-thiobarbituric acid, which was described previously [19]. $FeCl_2 \cdot H_2O_2$ was used to induce peroxidation of liver homogenate. A 0.2 mL volume of HE_ROS and HE_SOS at a concentration of 1.5 mg/mL was mixed with 1 mL of 1% rat liver homogenate, then 50 μ L H_2O_2 (0.5 mM) and 50 μ L $FeCl_2$ (0.5 mM) were added. The mixture was incubated for 60 min at 37°C, then 1 mL of 2-thiobarbituric acid (0.67%) and 1 mL of trichloroacetic acid (15%) were added. For 15 min, the mixture was heated in boiling water. The experiment was performed in triplicate, and the absorbance at 532 nm was read. Trolox was used as the reference substance. The percentage inhibition was calculated using the following formula: Percentage inhibition (%) = $[1 - (A_1 - A_2) / A_0] \times 100$

A_1 is the absorbance of the control (without sample); A_2 is the absorbance with the sample; A_0 is the absorbance without liver homogenate.

2.2.3. Anti-Inflammatory Activity

2.2.3.1. Lipoxygenase Inhibition Assay

Lipoxygenase inhibition was determined using linoleic acid (1.25 mM) as substrate [19]. Inhibitors (HE_ROS or HE_SOS/ Zileuton: reference substance) were prepared to a final concentration of 100 μ g/mL. A volume of 146.25 μ L of 15-lipoxygenase solution (820.51 U/mL) was added to 3.75 μ L of each inhibitor. Next, 150 μ L of linoleic acid was added. A spectrophotometer (Epoch Biotek Instruments, USA) was used to measure absorbances at 234 nm against enzyme-free blanks. The tests were carried out in triplicate, and the percentage of lipoxygenase inhibition was calculated using the formula:

$$\text{Inhibition (\%)} = [(AE - AI) / AE] \times 100$$

AE: Absorbance enzyme test - Absorbance blank; AI: Absorbance inhibition test - Absorbance blank.

2.2.3.2. Phospholipase A2 (sPLA2) Inhibition Assay

The sPLA2 activity of bee venom was determined according to the instructions of the manufacturer Abcam (Japan) described in catalog no. ab133089 [17, 19]. To perform the sPLA2 inhibition assay, a 96-well microplate was used. A final concentration of 100 μ g/mL of

HE_ROS, HE_SOS, and reference compounds (Betamethasone and Acetylsalicylic acid) were used. Absorbances were read spectrophotometrically (Agilent 8453) at 415 nm against a blank that had not received the enzyme. The experiment was performed in triplicate. The percentage inhibition of sPLA2 at 100 µg/mL was calculated using the following formula: Inhibition (%) = [(AE - AI)/AE] × 100.

AE: Absorbance of enzyme assay - Absorbance of blank; AI: Absorbance of inhibition assay - Absorbance of blank.

2.2.4. Acute Oral Toxicity

The acute oral toxicity test for HE_ROS and HE_SOS was performed on female mice in accordance with OECD guideline 423 [21, 22]. Two (02) batches, each consisting of three mice, were made up and placed separately in polypropylene cages: a test batch of three mice and a control batch of three mice. The extracts were administered by gavage using an esophageal tube in a single dose to the test mice, after fasting for three h. A dose of 2g/kg body weight (bw) of HE_ROS and HE_SOS was chosen as the starting dose. The control batch received the solvent for dissolving the extract (distilled water, 10 mL/kg). The mice were observed individually for two h after administration, at the end of which food was restored. They were then observed twice daily for a period of 14 days to monitor for mortality and toxidrome (signs of toxicity), such as changes in hair standing up, lack of appetite, convulsions, diarrhea, sleepiness, and coma. The quantities of food and water consumed and the weight of each mouse were measured every 2 days during the 14 days of experimentation. The mice were sacrificed and a necropsy was performed on the organs (liver, lungs, kidneys, heart and spleen) then weighed, on day 15. The relative weight of each organ was calculated [(Organ weight (g) / Fasting mouse weight on the day of sacrifice (g)) × 100]. After the mice were killed, the test was repeated under the same conditions as the first test (test batch and control batch).

2.3. Statistical analysis

Values are given as arithmetic means ± SD. The graphics were constructed using GraphPad Prism 8.4.3 Software, San Diego, CA. Statistical comparisons were performed using Student's T-test and one- and two-way ANOVA. A post hoc test was performed using Bonferroni's test analysis to compare all the groups. A *p*-value < 0.05 was considered statistically significant.

3. RESULTS

3.1. Phytochemical screening

3.1.1. Compounds in extracts revealed by HPTLC

The phytochemical analysis of HE_ROS and HE_SOS highlighted the presence of saponins, flavonoids, steroids and triterpenes, and tannins (Table I).

Table I: Phytochemical profile of hydroethanolic extracts of *c* revealed by HPTLC

| Extracts | Compounds | | | |
|----------|-------------|------------|--------------------------|---------|
| | Saponosides | flavonoids | steroids and triterpenes | tannins |
| HE_ROS | + | + | + | + |

HE_SOS + + + +

HE_SOS: Hydroethanolic extract of *O. strictum* stem; HE_ROS: Hydroethanolic extract of *O. strictum* root

3.1.2. Total phenolic and flavonoid contents in *Odontonema strictum* root and stem

The contents of total phenolics and flavonoid in HE_ROS and HE_SOS are recorded in the table II. HE_ROS and HE_SOS showed similar values for total phenolic compounds. However, the flavonoid content of HE_SOS was higher than that of HE_ROS ($p < 0.01$).

Table II: Total phenolics and flavonoid contents in *Odontonema strictum* root and stem extracts

| Extracts | Total phenolics (mg TAE/g) | Flavonoids (mg QE/g) |
|----------|----------------------------|----------------------|
| HE_SOS | 64.15±4.02 | 23.69±1.10 |
| HE_ROS | 57.85±3.69 | 12.92±1.96** |

QE: quercetin equivalent; TAE: tannic acid equivalent; ** $p < 0.01$ vs HE_SOS; $n = 3$

3.2. Antioxidant activity of extracts

The antioxidant activity of HE_ROS and HE_SOS is shown in Table III. The IC_{50} of the ABTS and DPPH tests were lower with Trolox than with the O2 extracts ($p < 0.001$). The percentage inhibitions of the LPO test were lower with Trolox than with the O2 extracts ($p < 0.001$). HE_ROS and HE_SOS at 100 $\mu\text{g/mL}$ were more effective than Trolox at inhibiting lipid peroxidation (LPO) ($p < 0.001$). However, there was no significant difference between the percentages of inhibition of O2 extracts by the DPPH and FRAP tests.

Table III: *In vitro* antioxidant activity of hydroethanolic extracts of *O. strictum* root and stem

| Extracts | ABTS | | DPPH | | FRAP | LPO |
|----------|--------------------------------|------|--------------------------------|------|----------------------------|----------------------------------------------|
| | IC_{50} ($\mu\text{g/mL}$) | ARP | IC_{50} ($\mu\text{g/mL}$) | ARP | mmol EAA/g | Inhibition (%) (at 100 $\mu\text{g/mL}$) |
| HE_SOS | 22.58±2.83*** | 0.04 | 32.59±4.35*** | 0.03 | 565.39±12.89 | 62.24±5.38* |
| HE_ROS | 9.97±2.75*** $\phi\phi$ | 0.10 | 29.18±2.94*** | 0.03 | 719.34±6.49 $\phi\phi\phi$ | 73.61±6.42** |
| Trolox | 2.04±0.12 $\phi\phi\phi$ | 0.49 | 5.06 ± 0.15 $\phi\phi\phi$ | 0.19 | ----- | 48.11±3.88 $\phi\phi$ |

IC_{50} : inhibition concentration 50%; ARP: anti-free radical power; $n = 3$; * $p < 0.05$ vs Trolox; $\phi\phi$ $p < 0.01$ vs HE_SOS, EAA: Ascorbic acid equivalent.

3.3. Anti-inflammatory activity *in vitro* of *Odontonema strictum* root and stem extracts

The evaluation of the *in vitro* anti-inflammatory activity of *Odontonema strictum* root and stem extracts by inhibiting 15-lipoxygenase and Phospholipase A_2 is recorded in Table IV. HE_ROS and HE_SOS have weak inhibitory effects on 15-lipoxygenase and Phospholipase A_2 compared with Betamethasone and Zileuton ($p < 0.001$).

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Table IV: 15-Lipoxygenase and Phospholipase A₂ inhibitory activity of *Odontonema strictum* root and stem extracts

| Extracts | 15-Lipoxygenase IC ₅₀ (µg/mL) | Phospholipase A ₂ Inhibition (%) |
|----------------------|---------------------------------------------|------------------------------------------------|
| HE_SOS | 18.31±1.09*** | 7.39±1.04 ^{φφφ###} |
| HE_ROS | 15.73±2.23*** | 6.77±0.56 ^{φφφ###} |
| Zileuton | 2.92±0.32 | ---- |
| Betamethasone | ---- | 35.39±3.31 |
| Acetylsalicylic acid | ---- | 58.18±3.53 |

HE_SOS: Hydroethanolic extract of *O. strictum* stem; HE_ROS: Hydroethanolic extract of *O. strictum* root; ***p<0.001 vs Zileuton; ^{φφφ}p<0.001 vs Betamethasone; ^{###}p<0.001 vs Acetylsalicylic acid; n = 3

3.4. Acute oral toxicity

3.4.1. Mortality and toxidrome

The dose of 2000 mg/kg body weight (bw) showed no remarkable behavioral changes or mortality in female mice at the first and second stages of administration of HE_ROS and HE_SOS (Table V).

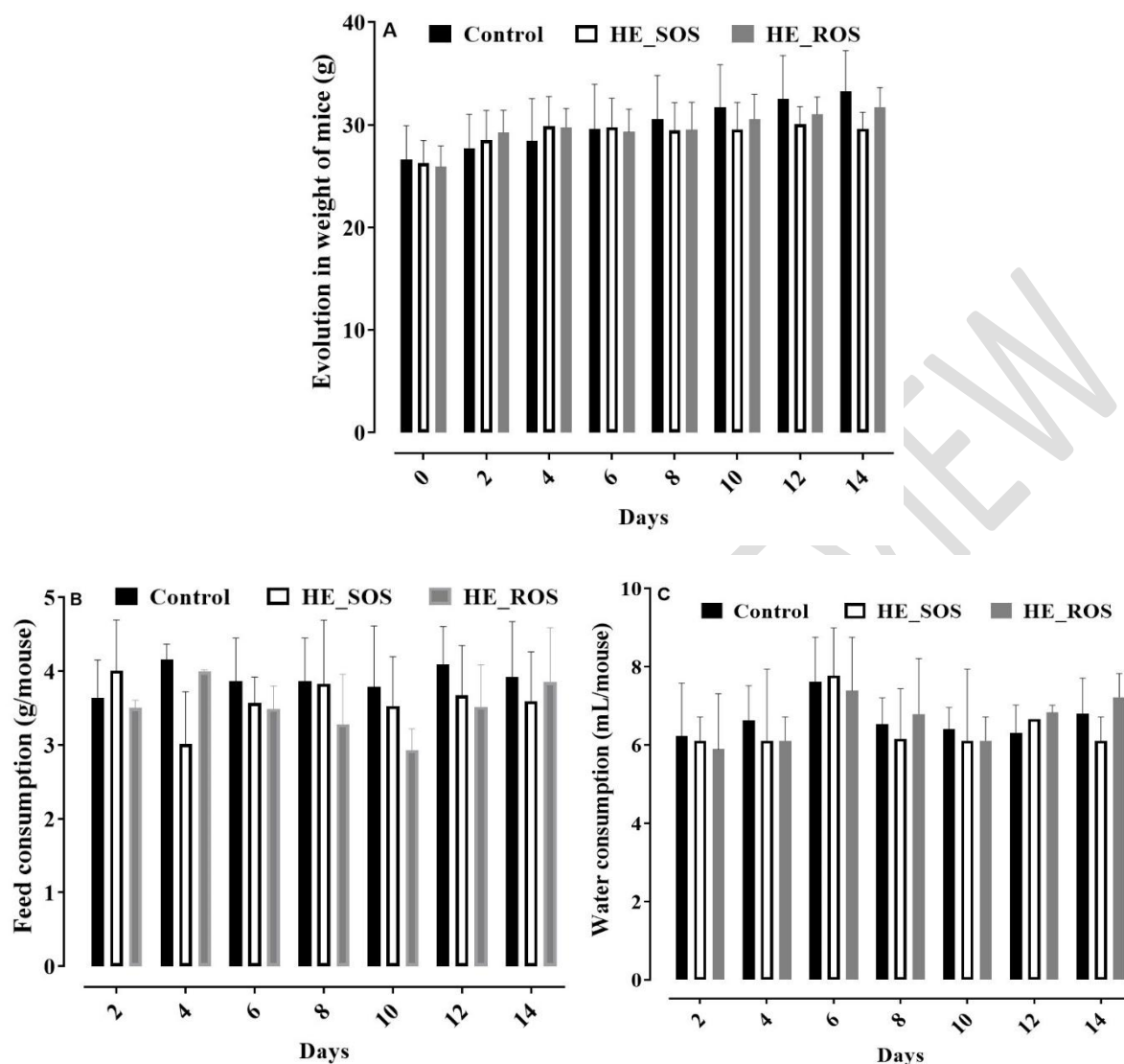
Table V: Mortality of female mice administered a single dose of *O. strictum* root (HE_ROS) and stem (HE_SOS) extracts

| Extracts administered / Behaviour of mice | Mortality | |
|----------------------------------------------|----------------------|----------------------|
| | 1 st test | 2 nd test |
| Control (Distilled water) | 0/3 | 0/3 |
| HE_ROS(2000 mg/kg) | 0/3 | 0/3 |
| HE_SOS(2000 mg/kg) | 0/3 | 0/3 |
| Convulsions | - | - |
| Sleepiness | - | - |
| Hair standing up | - | - |
| Lack of appetite | - | - |
| Diarrhea | - | - |
| Hyperventilation | - | - |

HE_SOS: Hydroethanolic extract of *O. strictum* stem; HE_ROS: Hydroethanolic extract of *O. strictum* root; n = 6

3.4.2. Changes in Body Weight, Food, and Water Consumption of Mice

Figure 1 shows the mean weight gain, feed consumption, and water consumption for two weeks in female mice given a vehicle (distilled water), and a single dose (2000 mg/kg) of HE_ROS and HE_SOS. No statistically significant differences were observed between the different batches in the three parameters assessed (p > 0.05).



HE_SOS: Hydroethanolic extract of *O. strictum* stem (2000 mg/kg); HE_ROS: Hydroethanolic extract of *O. strictum* root (2000 mg/kg)

Figure 1: Evolution in weight (A), feed (B), and water (C) consumption of female mice from *Odontonema strictum* root and stem extracts tests and control batches during 14 days of follow-up; n = 6

3.4.3. Macroscopic Observation and Relative Organ Weights of Mice

Fresh macroscopic examination of vital organs such as the lungs, liver, heart, kidneys, and spleen of control mice and mice treated with HE_SOS (2000 mg/kg) and HE_ROS (2000 mg/kg) showed no lesions or changes in the color or appearance of the various organs. Figure 2 shows the relative organ weights of the control and extract-treated batches of mice. No statistically significant variation was observed between the relative organ weights of the 03 batches of mice.

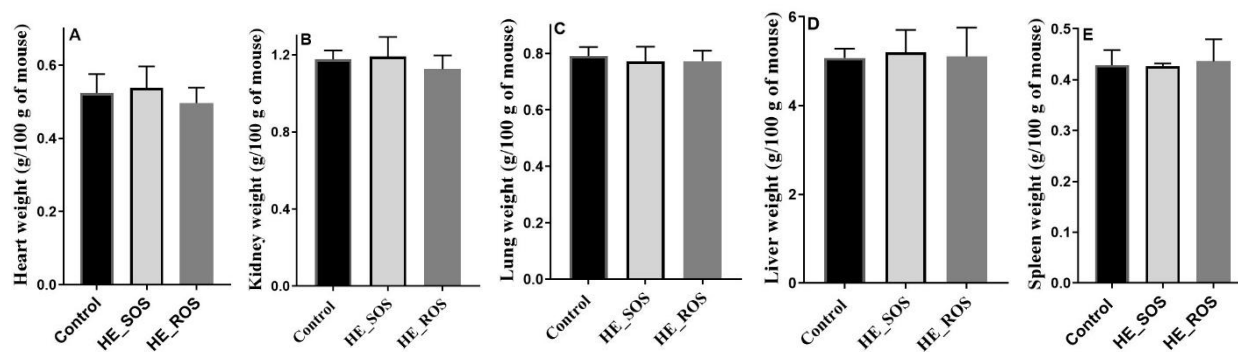


Figure 2: Relative weights of vital organs of control and hydroethanolic extracts of *O. strictum* root (HE_ROS, 2000 mg/kg) and Stem (HE_SOS, 2000 mg/kg) treated mice; n=6

4. DISCUSSION

To our knowledge, this is the first work carried out on the plant's stems and roots. In the search for the biological properties of a plant drug, phytochemistry is a very important tool for responding to certain research hypotheses. Thus, we have demonstrated the presence of tannins, saponosides, sterol-triterpenes, and flavonoids in hydroethanolic extracts from *O. strictum* root (HE_ROS) and Stem (HE_SOS). These compounds are known for their vasorelaxant properties [10, 21]. *O. strictum*, an ornamental plant from Latin America, is traditionally used for the management of arterial hypertension [9]. In addition, our findings corroborate previous studies. Indeed, authors have isolated flavonoid O-heterosides and flavonoid C-heterosides from *O. strictum* leaves [8]. In addition, the leaves and flowers of *Odontonema strictum* contain polyphenols such as verbascoside and isoverbascoside, carbohydrates, flavonoid saponins, glycosides, tannins, steroids, and terpenoids as well as β -Sitosterol and Stigmasterol [13, 15]. The pathophysiological mechanism of cardiovascular pathologies is multifactorial and includes inflammation, oxidative stress, the renin-angiotensin system, and vascular dysfunction [23-25]. To this end, we have formulated research hypotheses to the effect that both extracts possess antioxidant and anti-inflammatory properties. In addition, natural antioxidants act beyond their capacity to mitigate oxidative stress by blocking intracellular signaling cascades. Indeed, the imbalance between oxidizing species and antioxidant compounds can increase the noxious species that induce functional modulation of lipids, proteins nucleic acids, and structural modifications. The result of these reaction cascades is chronic inflammatory and cardiovascular disease [26, 27]. Interestingly, our research highlighted these two properties of the extracts. These results are in line with the literature, which has documented the antioxidant properties of extracts from the leaves of this plant [11-13]. These properties could provide a vascular protective effect by blocking reactive oxygen species, which are known to have vasoconstrictive effects and lead to endothelial dysfunction. Antioxidant compounds have already been shown to play an important role in the prevention of cardiovascular disease [28, 29]. Both extracts, therefore, have the ability to trap free radicals. Several concordant studies have shown a correlation between the presence of phenolic compounds and flavonoids and antioxidant activity based on DPPH, ABTS, and FRAP tests [16, 30]. Moreover, in the hypertension mechanism, inflammation of the vessel cannot be ignored, hence the search for anti-inflammatory properties in the extracts. Overall, HE_SOS and HE_ROS showed inhibition of phospholipase A₂ and 15-lipoxygenase. These anti-inflammatory activities were less effective than Betamethasone and Zileuton. The flavonoids and sterols/triterpenes in HE_SOS and HE_ROS are known for their ability to inhibit pro-inflammatory enzymes [19]. However, a medicinal product can only be used if it is both effective

and non-toxic. So, the safety of a pharmaceutical product is a very important criterion in therapeutics. As a result, the use of plant extracts in alternative medicine requires vigilance in terms of safety. With this in mind, the acute oral toxicity of HE_SOS and HE_ROS was assessed. Interestingly, the results showed that HE_SOS (2000 mg/kg bw) and HE_ROS (2000 mg/kg bw) did not cause any mortality or visible behavioral changes in female NMRI mice. The LD₅₀ of HE_SOS and HE_ROS is estimated at 5000 mg/kg bw according to the United Nations Globally Harmonised System with demonstrated adverse effects [22, 31]. These results show that extracts from the stems and roots of *Odontonema strictum* can therefore be used safely. In relation to the literature, this study constitutes, to our knowledge, the first toxicity studies on extracts from this plant. However, the mechanism of action of these extracts on cardiovascular pathologies requires preclinical investigations, in particular the bioguided evaluation of their muscle relaxant properties *ex-vivo*, their antihypertensive properties *in vivo* and their oral toxicity at repeated doses.

5. CONCLUSION

This study is the first to our knowledge to identify phytochemical groups such as saponosides, tannins, flavonoids, sterol-triterpenes, and polyphenols in the stems and roots of *Odontonema strictum*. The antioxidant and anti-inflammatory properties of these two hydroethanolic extracts have also been proven. These phytoconstituents and properties against free radicals are beneficial in the treatment of cardiovascular pathologies. Extracts from the stems and roots of *Odontonema strictum* are therefore potential research substances in the pre-clinical investigation of the antihypertensive properties of this plant, which is widely used in traditional medicine.

CONSENT

It is not applicable.

ETHICAL APPROVAL

The experiment was carried out following the procedures of the Guide of Good Practices in Animal Experimentation under the Declaration of Helsinki. Furthermore, the experimental animal procedures have been performed by the Guide for the Care and Use of Laboratory Animals of the US National Institutes of Health and the EU Directive 2010/63/EU for animal experiments.

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