Investigational
Medicinal Chemistry & Pharmacology

Research Article Open Access

Antiamnesic effect of aqueous lyophilisate of *Drymaria cordata* on scopolamine-induced amnesia and oxidative stress in mice

Gwladys Temkou Ngoupaye[1]*, Tatiana Diebo Kom[1], Maxwell Blesdel Adassi[2], Joel Yaya[3], Chrétien Mbeugangkeng Noungoua[1], Aurelien Fossueh Foutsop[1], Elisabeth Ngo Bum[2]

Abstract

Background: Learning and memorization are the so-called higher functions of the brain whose alteration is at the origin of neurodegenerative diseases. *Drymaria cordata* (*D. cordata*) is a plant used in Cameroon to treat disorders such as convulsions and ulcers. The aim of this study was to evaluate the anti-amnestic effects of *D. cordata* on scopolamine-induced amnesia in mice and its potential antioxidant properties.

Methods: The Morris water maze was used to evaluate the spatial memory. Mice of both sexes were randomly divided in six and five groups and treated for 15 days with one of the following substances: distilled water, tacrine or *D. cordata*. The animals were simultaneously treated with scopolamine from day 12 to day 15 to induce amnesia. Assessment of *D. cordata* on memory was done by treating animals for 15 days without scopolamine. The Morris water Maze (MWM) and hippocampus acetylcholinesterase activity were used to assess memory integrity. Malondialdehyde and reduced glutathione levels were quantified in the hippocampus to assess antioxidant properties.

Results: *D. cordata* reversed scopolamine-induced amnesia in the Morris water maze as it spent more time in the target quadrant ($p<0.01$) and reduced acetylcholinesterase activity. *D. cordata* decreased malondialdehyde level, and increased glutathione level in the hippocampus of mice with amnesia ($p<0.01$) as compared to mice treated with distilled water. Mice treated only with *D. cordata*, spent more time in the target quadrant, decrease the acetylcholinesterase activity, reduced the MDA level although not significantly and significantly increased the glutathione level as compared to mice treated with distilled water($p<0.05$).

Conclusion: These results suggest that *D. cordata* improves scopolamine-induced cognitive impairment through inhibition of oxidative stress and potentiation of cholinergic neurotransmission.

Keywords: Amnesia; cognitive impairment; *Drymaria cordata*; reduced glutathione; malondialdehyde; acetylcholinesterase.

*Correspondence: Tel:+691508707 ; Email: gtngoupaye@gmail.com (Gwladys Temkou Ngoupaye)
[1]Department of Animal Biology, University of Dschang, P.O. Box 67,Dschang, Cameroon; [2]Department of Biological Sciences, Faculty of Science, University of Maroua, P.O. Box 814, Maroua, Cameroon; [3]Institute of Medical Research and Studies of Medicinal Plants, P.O. Box 8013, Yaoundé, Cameroon

Citation on this article: Ngoupaye GT, Kom TD, Adassi MB, Yaya J, Noungoua CM, Foutsop AF, Ngo Bum E. Antiamnesic effect of aqueous lyophilisate of Drymaria cordata on scopolamine-induced amnesia and oxidative stress in mice. Investigational Medicinal Chemistry and Pharmacology (2020) 3(2):45; Doi: https://dx.doi.org/10.31183/imcp.2020.00045

Background

Cognitive impairment is a deterioration of the mental processes of memory, judgment, understanding and reasoning [1]. Cognitive impairment affects approximately 50 million people worldwide and is manifested by the progressive deterioration of cognitive functions such as memory, thinking and behavior [2]. Aging, depression and anxiety are often associated with problems of memory. However, memory disorders are primarily associated with a dysfunction of the cholinergic system that involves its neurotransmitter acetylcholine and its receptors, since acetylcholine seems to be the most involved neurotransmitter in neurodegenerative disorders [3]. Structures of the nervous system particularly the brain are susceptible to deterioration by reactive oxygen species because they require large supplies of oxygen for their proper functioning and have reduced antioxidant defense system. These reactive oxygen species are responsible for the lipid peroxidation which leads to neuronal degeneration, particularly the cholinergic neurons of the central nervous system [4]. Presently, drug treatments do not really help to stop amnesic disorders since they generally have short half-lives and adverse reactions, including hepatotoxicity, sickness and nausea. By contrast, herbal medicine exhibits fewer side effects and drug interactions, hence the use of herbal medicine [5]. Herbal medicine for amnesia is based on a number of herbal drugs that were often used in the past, but with recent pharmacological and clinical investigations revealing their anti-amnestic properties [3]. Nowadays, traditional medicine is very popular, surely because arguments suggest that medicinal plants are inexhaustible reservoirs of drugs presenting better compatibility with the human body, and possessing relatively few adverse effects [6]. *D. cordata* is a plant used in Cameroon and other African countries for its antitussive, anti-inflammatory, anxiolytic, cytotoxic, analgesic and antipyretic properties and to treat various disorders such as convulsions and ulcers, and it is also empirically used to treat memory disorders [7]. The aim of this study was to evaluate the scopolamine-induced anti-amnestic properties as well as the potentiating and antioxidant properties of the aqueous lyophilisate of *D. cordata* in mice.

Methods

Plant material and extract preparation

The whole plant of *D. cordata* was harvested in March 2019 at the locality of Bayangam, West Cameroon, and shade dried. A specimen of *D. cordata* was identified at the National Herbarium of Cameroon in comparison with SRF sample 2433534, registration No. 8483/HNC. A mass of 900 g of powder was introduced into 9 liters of distilled water and allowed to macerate for a period of 24h. The preparation was successively filtered using a sieve, hydrophilic cotton, and then filter paper No. 4. The filtrate was subsequently lyophilized at 0 ° C. At the end of the process, a mass of 151 g of dry extract was obtained, thus giving an extraction yield of 16.7%.

Animals

Mus musculus Swiss mice from both sexes aged between 2 and 3 months weighing between 18 and 25 g were used for this study. They were raised in polyacrilic cages at room temperature and subjected to a natural light-dark cycle at the animal house of the Department of Animal Biology of University of Dschang Cameroon. Mice received water and food *ad libitum*. Animals were treated in accordance with the guidelines of the Cameroonian bioethics committee (reg N. FWA IRB00001954) and in accordance with NIH-Care and Use of Laboratory Animals manual. Efforts were also made to minimize animal suffering and to reduce the number of animals used in the experiment.

Distribution and treatment of animals

The following substances were used for the study: Scopolamine (1 mg/kg, Sigma-Aldrich, St. Louis, USA) and tacrine (10 mg/kg, Sigma-Aldrich, St. Louis, USA) injected intra- peritoneally (ip). However, distilled water and plant extract were administered orally (gavage). A total of 72 animals were used for both tests and were divided into two subsets. Subset A was allocated for induction of amnesia using scopolamine. Subset B was allocated to animal receiving only the lyophilisate for the potentiation test. In subset A, 42 animals were used and further divided into six groups (seven per group) and received treatment from day 1 to day 14 as follows: group I received distilled water and served as vehicle, group II also received distilled water and served as negative control, group III received tacrine and served as a positive control, groups IV, V and VI received *D. cordata* at doses of 263, 526 and 1052 mg/kg. From the day 12 to the day 15 apart from the group I all the groups received the scopolamine (1 mg/kg) and were submitted to behavioral test. In the subset B concerning the potentiation test, no administration of scopolamine was made. A total number of 30 animals were distributed into five groups (six per group) as follow: group I received distilled water and served as negative control, group II received tacrine and served as a positive control, groups III, IV, and V received *D. cordata* at doses of 263, 526 and 1052 mg/kg. These different groups of animals were subjected to cognitive behavioral test namely the Morris water maze (MWM). This behavioral test started from the day 12 of treatment and ended on day 15 (Figure 1) [4].

Morris water maze test

The Morris water maze is an aquatic device typically used in behavioral neuroscience to evaluate rodent memory. Indeed, it is a device that can be compared to a circular pool (100cm in diameter and 45cm high) half filled with water (25 °C) and divided into four quadrants of equal area. In one of these quadrants, there is a platform (6cm wide and 29cm high) submerged 1cm below the surface of water to remain invisible at water level [8]. The distance between the quadrant and the platform is 30cm. The principle of its utility lies in the motivation of the animal to escape the aversion caused by water, the animal must find and climb as quickly as possible on the platform. The position of the platform remains unchanged, unlike the starting position of the rodent, which varies from quadrant to quadrant over the tests. Signals distributed around the pool are used to allow the animal to navigate easily, and the entry of the animal into the pool is done in such a way that the animal is facing a signal and his back is facing the observer. These signals are located in the middle of each quadrant and represent the different points of entry of the animal. The test was conducted in two phases, one of which was the training, conducted the first three days, and the actual test ("Probe test") which took place on the fourth day. The first days, the mouse was placed in a point of the pool and for a maximum duration of 1 min, the search for the platform was observed. If at the end of the 60s the animal did not find the platform, the observer guided him by the hand on the platform where the animal was allowed for 20s before being removed from the pool. On the 4th day, the platform was removed from the pool and the animal was allowed to swim for 60s during 4

trials. Each trial was separated from the other by a duration of 5min. The parameter measured was the time spent in the quadrant where the platform was located [9]. During each trial of the training phase, the latency to find the platform was noted; this represents the index of acquisition and learning [4].

Biochemical tests

Homogenates preparation

Immediately after the last test (15th day), the animals were sacrificed, and the brain of each animal was carefully isolated. Hippocampus were ground to homogenate (10% w/v) in a porcelain mortar. Each of the homogenates was prepared using a solution of 0.1 M phosphate buffer containing 1% Triton-100X (pH 7.4). These homogenates were individually centrifuged for 15min (3000 rpm) and the supernatant were collected for various assays [9].

Evaluating the effect of D. cordata extract on acetylcholinesterase activity

A volume of 1000 µL of buffer, 10 µL of DTNB and 25 µL acetylthiocholine iodide were introduced into an ependorf tube. The resulting solution was used as blank. For the assay samples, 10 µL of the homogenates were added to the previous solution and the absorbance was read at 412 nm. Each reading was repeated three times and the average of the 3 values was retained. Measurements were done using a BIORAD spectrophotometer, SMART SPEC 3000 (USA). The gradual increase in absorbance was recorded for 5 minutes and the enzymatic activity expressed in nmol/min/mg of protein. Proteins were measured with a standard commercially available kit (Randox).

Evaluating the effect of D. cordata extract on reduced Glutathione level

A volume of 1500 µL of the Ellman reagent DTNB (0.1 mM 5,50-dithio bis-2-nitrobenzoic acid in 0.3 M phosphate buffer with 1% of sodium citrate solution) was introduced into tubes previously containing 100 µL of homogenate (test tube) and 100 µL of phosphate buffer (PBS) then the mixtures were incubated for 1 hour at room temperature and the absorbance was read using a BIORAD spectrophotometer SMART SPEC 3000 (USA) at 412nm against the blank and results were expressed in µmol/mg of proteins.

Evaluating the effect of D. cordata extract on malondialdehyde level

A volume of 250 µL of the homogenate was introduced in tests tubes. 250 µL of 20% trichloroacetic acid (TCA), 500 µL of 0.67% thiobarbituric acid (TBA) and 10 µL of 0.1% BHT (Butylated hydroxytoluene) were added to each tube. The blank solution consisted of all the above stated elements except the homogenate. The tubes were sealed and incubated for 10 minutes at 90 °C and then cooled with tap water. The result was centrifuged at 3000 rpm for 15 minutes at room temperature. The supernatant was pipetted, and the absorbance read at 532 nm on a BIORAD spectrophotometer, SMART SPEC 3000 (USA) against the blank and results were expressed in nmol/mg of proteins.

Phytochemical characterization tests

Phytochemical characterization tests for alkaloids, phenolic compounds, catechic tannin and flavonoids of *D. cordata* macerate were realized using qualitative methods for the determination of principal chemical groups implicated in the treatment of central nervous system diseases [9].

Statistical analysis

The results were analyzed using Graph Pad Prism software version 5.0. They were presented as mean ± Standard Error on Mean (SEM). The t-test and the 01-way ANOVA followed by Newman-keuls post hoc test was used for the multilateral comparison of groups and 02-way ANOVA followed by the Bonferonni test compared the averages for bivariate tests. The tests were significant when $p < 0.05$.

Results

Phytochemical characterization

Results of phytochemical characterization tests show the presence of alkaloids, phenolic compounds and catechic tannin in the plant decoction of *D. cordata* (Table 1).

Effects of aqueous lyophilisate of D. cordata on learning and memory assessed in the Morris maze in scopolamine-induced anterograde amnesia in mice

The lyophilisate of *D. cordata* at the dose 263 mg/kg significantly decreased the latency to find the platform, similar to the vehicle compared to the negative control ($p < 0.05$). Tacrine decreased latency in finding the platform in subjects treated in a non-significant manner (Figure 2a). The negative control spent less time in the target quadrant compare to the vehicle [$F(2,20) = 4.769$; $p=0.0218$]. The aqueous lyophilisate of *D. cordata* at the dose of 526 mg/kg significantly increased the time spent in the quadrant in the treated subjects compared to the negative control [$F(5,415,471$; $p=0.0008$]. A significant increase was also observed in the Tacrine group, compared to the negative control ($P < 0.01$; $P < 0.05$) (Figure 2b).

Effect of aqueous lyophilisate of D. cordata on acetylcholinesterase activity in the hippocampus of mice

The negative control showed a significant increased acetylcholinesterase activity ($P=0.0158$) compared to the vehicle. *D. cordata* (526 mg/kg) significantly decreased the level of acetylcholinesterase activity when compared to animals in the negative control group ($p =0.0327$ (Figure 3).

Effect of aqueous lyophilisate of D. cordata on reduced Glutathione and Malondialdehyde (MDA) concentration in the hippocampus of mice

There was no significant variation in glutathione levels in the various treated groups. However, tacrine showed a significant increase in reduced glutathione compared to the negative control [$F(2,11)= 9.771$; $p=0.0056$] ($p < 0.01$) (Figure 4a).

Animals treated with distilled water and scopolamine showed a non-significant increase in MDA concentration compared

to animals in the vehicle group. Animals treated with the aqueous lyophilisate of *D. cordata* at the dose 526 mg/kg showed a significant decreased in MDA concentration compared to animals in the negative control group (p =0.0362) (Figure 4b).

Effect of the aqueous lyophilisate of D. cordata on learning in the Morris water maze

The aqueous lyophilisate of *D. cordata* at a dose of 526 mg/kg showed a relative and non-significant decreased in the latency in recovering the platform when compared to the negative control (P>0.05) (Figure 5a). Animals treated with the aqueous lyophilisate of *D. cordata* at a dose of 526 mg/kg seems (p = 0.0894) to spend more time in the reference quadrant compared to animals in the group receiving distilled water (Figure 5b).

Effects of aqueous lyophilisate of D. cordata on acetylcholinesterase activity of mice

The activity of acetylcholinesterase did not show considerable change in subjects treated with *D. cordata* at the dose of 526 mg/kg compared to the vehicle group. However, its activity was significantly increased in subjects treated with *D. cordata* at the dose of 1052 mg/kg compared to the neutral control group [F(2,11)= 9.122; p=0.0068] (Figure 6).

Effects of aqueous lyophilisate of D. cordata on reduced glutathione and MDA concentrations

Animals treated with *D. cordata* at all the doses showed a significant increase in reduced glutathione concentration compared to vehicle F(3,15)= 5.923; p= 0.0102]with a particular increase at the dose (526 mg/kg) F(3,15)= 3.589; p= 0.0465] (p <0.05) (Figure 7a).

Animals treated with distilled water showed a concentration in MDA relatively equal to that of the animals treated with aqueous lyophilisate of *D. cordata* at the dose (526 mg/kg) (Figure 7b).

Discussion

The aim of this study was to evaluate the anti-amnestic and potentiating properties of the aqueous lyophilisate of *D. cordata* on the memory, using the Morris water maze. The Morris water maze is a validated device for the study of spatial memory [8] specifically the involvement of the hippocampus in spatial memory, which is a component of long-term memory [10]. Amnesia was induced following scopolamine (1 mg/kg) injection. It has been shown that scopolamine acts passively and acts at two stages in the process of memorization, including acquisition and consolidation stages [11]. This justifies the fact that animals treated only with scopolamine are unable to learn with time and increased number of injections [11]. The results obtained in the Morris water maze showed that the aqueous lyophilisate of *D. cordata* decreased the latency to reach the platform compared to the negative control. The fact that the lyophilisate decreased the time to reach the platform on the third day would reflect an improvement in the learning process during the training phase. On the other hand, this can also be evidenced by the fact that the aqueous lyophilisate of *D. cordata* (526 mg/kg) significantly increased the time spent in the reference quadrant on the fourth day in the Morris water maze, in contrast to animals receiving distilled water and scopolamine, which time spent in the reference quadrant have decreased. These results are similar to the results obtained by Ngoupaye et al. [4] who showed that the aqueous lyophilisate of *Gladiolus dalenii* significantly reduced the time to find the platform on the third day with scopolamine-treated rats and that these animals spent a significantly long time in the reference quadrant in the Morris water maze. This would suggest anti-amnestic properties on scopolamine-induced amnesia and possible involvement of the hippocampus in *D. cordata* activity.

Currently used to induce anterograde amnesia, scopolamine is also known to induce oxidative stress [12]. Indeed, in amnesic patient, it has been shown that glutamate level is increased in some cases, due to a continuous and not phasic stimulation of the glutamate NMDA and AMPA receptors [13]. This increase in the activity of glutamatergic neurons induces glutamate toxicity at the brain level, thus inducing oxidative stress [14]. The evaluation of the antioxidant effect of *D. cordata* in scopolamine-induced amnesia was made on two parameters, the malondialdehyde (MDA) and reduced glutathione [15].

In order to further understand the memory impairment induced by the scopolamine, acetylcholinesterase activity was assessed in the hippocampus. Indeed, Excessive acetylcholinesterase activity leads to constant acetylcholine deficiency and has been associated with memory deficits [16,8]. Scopolamine was able to increase the acetylcholinesterase activity on animal treated with distilled water compared to the vehicle, confirming the memory impairment seen on the behavioral test. *D.cordata* (526 mg/kg) was able to inhibit this activity justified by its decreased levels, confirming as well the increased time spent in the reference quadrant on the fourth day.

Scopolamine promotes an increase in tissue concentration of malondialdehyde which is the best known biomarker of lipid peroxydation, resulting from the degradation of the hydro-peroxides formed during lipid peroxidation and causes the degeneration of several neurons of the central nervous system and especially the neurons involved in the cholinergic system, hence the failure in learning and memorization observed in animals treated with scopolamine [4]. Animals treated with *D. cordata* at the dose of 526 mg/kg after induction of amnesia with scopolamine showed a significant decrease in malondialdehyde level in hippocampal homogenates compared to the negative control group. The lyophilisate of *D. cordata* thus inhibited lipid peroxidation, hence the decrease in malondialdehyde concentration in the treated subjects, thus suggesting its antioxidant properties. The lyophilisate of *D. cordata* did not have a marked effect on the level of reduced glutathione in scopolamine-treated animals. An attempt to understand the mechanism of *D. cordata* in improving cognitive impairment was done by assessing its effects in the absence of scopolamine. In the Morris water maze, the extract decreased latency in finding the platform during the first three days of training. Animals treated with *D. cordata* at the dose of 526 mg/kg seemed (p = 0.0894) to spend more time in the reference quadrant on the fourth day compared to those of the negative control group. Thus, the effect of the lyophilisate of *D. cordata* seems to potentiate the memory. The lyophilisate of *D. cordata* would have effects in terms of memorization. It has been established that the memorization process results in a large and long-lasting increase in synaptic efficiency, involving the mechanism of long-term potentiation [17]. It is generally recognized that long-term potentiation, after a high-frequency stimulation protocol, requires the activation of NMDA-type glutamate receptors responsible of Ca^{2+} fluxes associated with their activation; resulting in changes in synaptic efficiency [18]. Thus, the lyophilisate of *D. cordata* might act at several levels in the process of long-term

potentiation, either by activation of NMDA-type glutamate receptors or by synchronous activation of the pre- and post-synaptic elements, causing an increase in efficiency of synaptic transmission in the hippocampus that induces long-term potentiation in the prefrontal cortex. One of the important properties of the brain is synaptic plasticity, which allows the brain to learn and remember experiences in order to improve its behavior [19]. The aqueous lyophilisate of *D. cordata* could act by this signaling pathway, establishing new connections between the different parts of the brain, thus strengthening the communication within one or more groups of neurons, unlike scopolamine whose Long-term administration may inhibit the survival of newly generated nerve cells, as well as their proliferation and differentiation in the dentate gyrus of the hippocampus [20].

Phytochemical analysis of *D. cordata* aqueous lyophilisate showed the presence of alkaloids, phenolic compounds and catechic tannins. Some alkaloids are the agonist of muscarinic receptors, inhibit the acetylcholinesterase activity and have antioxidant effects [21]. Many phenolic compounds also have antioxidant effects [22].

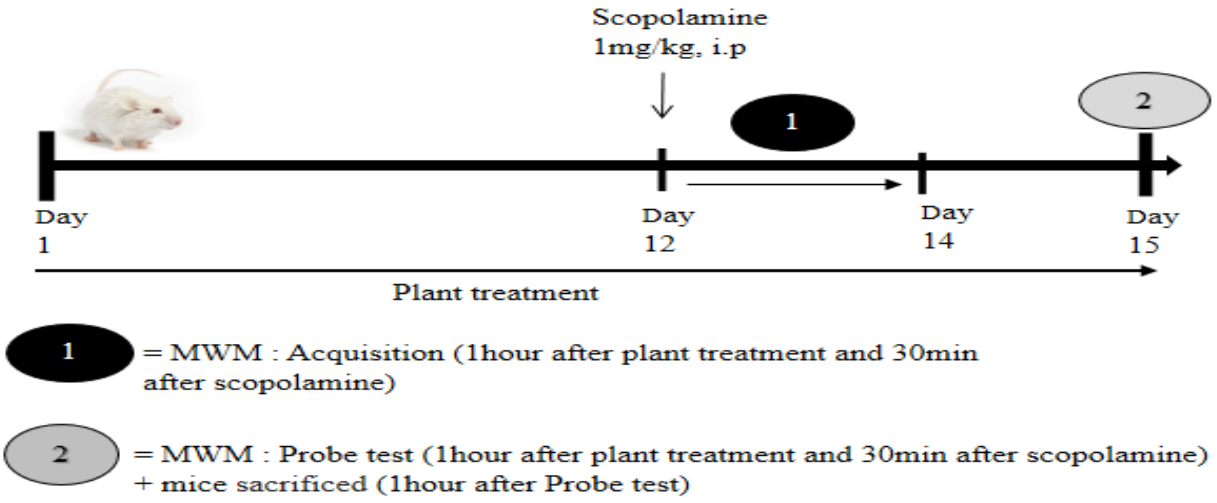

Figure 1. Diagrammatic depiction of the experimental procedure

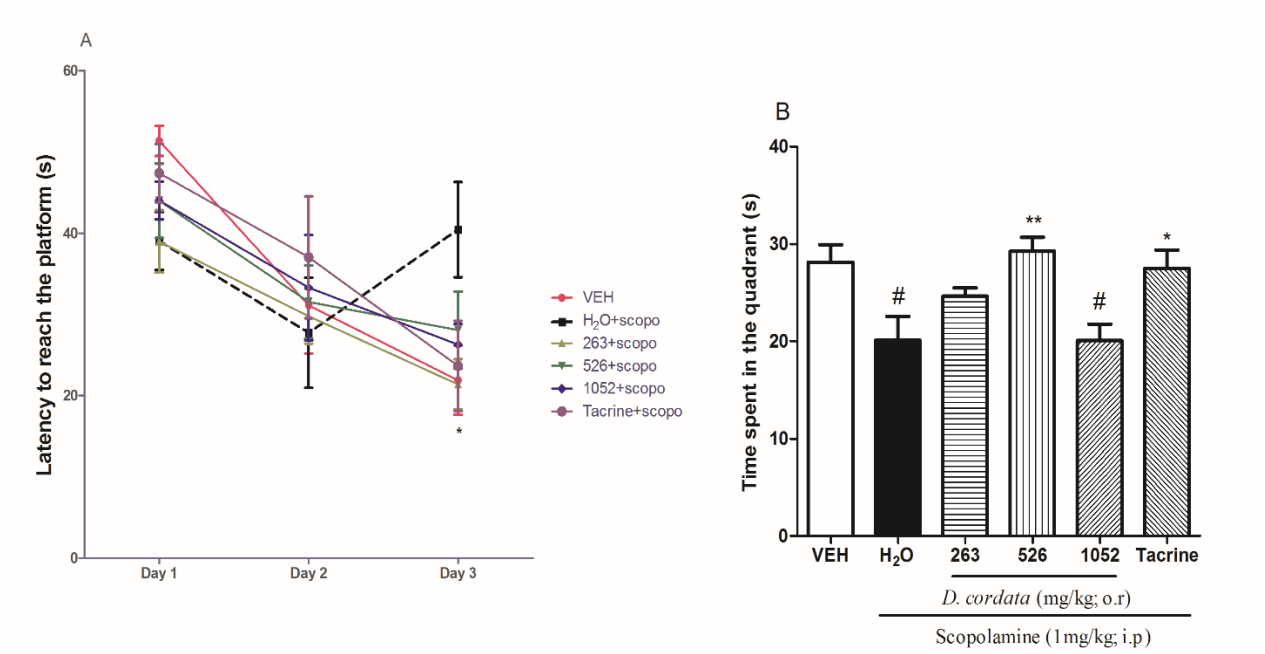

Figure 2. Effects of aqueous lyophilisate of *D. cordata* on learning and memory assessed in the Morris maze in scopolamine-induced anterograde amnesia in mice.

(A) Represents the latency to reach the hidden platform. (B) Represents the time spent in the target quadrant. N = 7. All the data are expressed as mean SEM. * p <0.05 when compared to H_2O. **p <0.01 when compared to H_2O. #p<0.05 when compared to VEH. H_2O = Distilled water. VEH=Vehicle. One-way ANOVA followed by Student Newman keuls

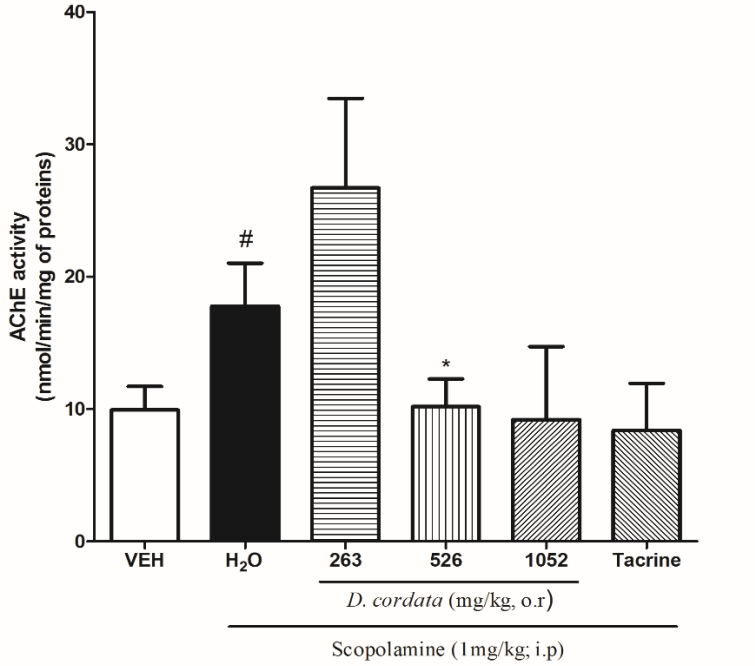

Figure 3. Effect of aqueous lyophilisate of *D. cordata* on acetylcholinesterase activity in hippocampus of amnesic mice.
Data expressed as mean ± SEM. n = 4. * p <0.05 when compared to H_2O; #p<0.05 when compared to VEH. H_2O = Distilled water. VEH=Vehicle.

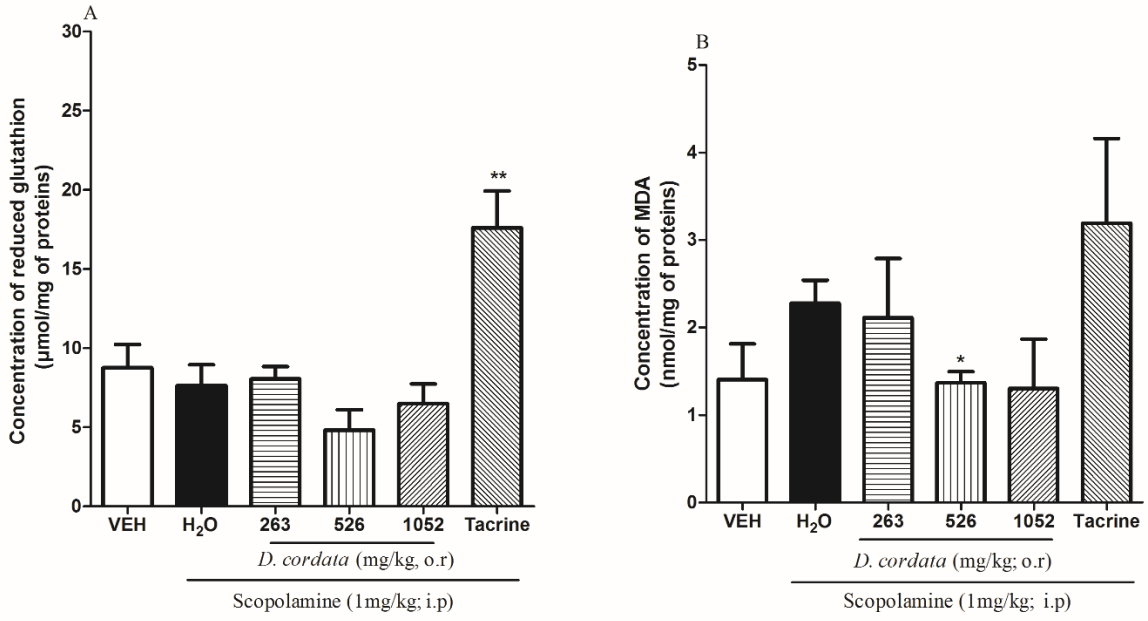

Figure 4. **Effect of aqueous lyophilisate of *D. cordata* on reduced glutathione concentration and malondialdehyde concentration in hippocampus of amnesic mice.**
Data expressed as mean ± SEM. n = 4. ** p <0.01 when compared to H_2O with t-test and one-way ANOVA followed by Student Newman keuls (A).* p <0.05 compared to H_2O with t-test. H_2O= distilled water. VEH=Vehicle (B).

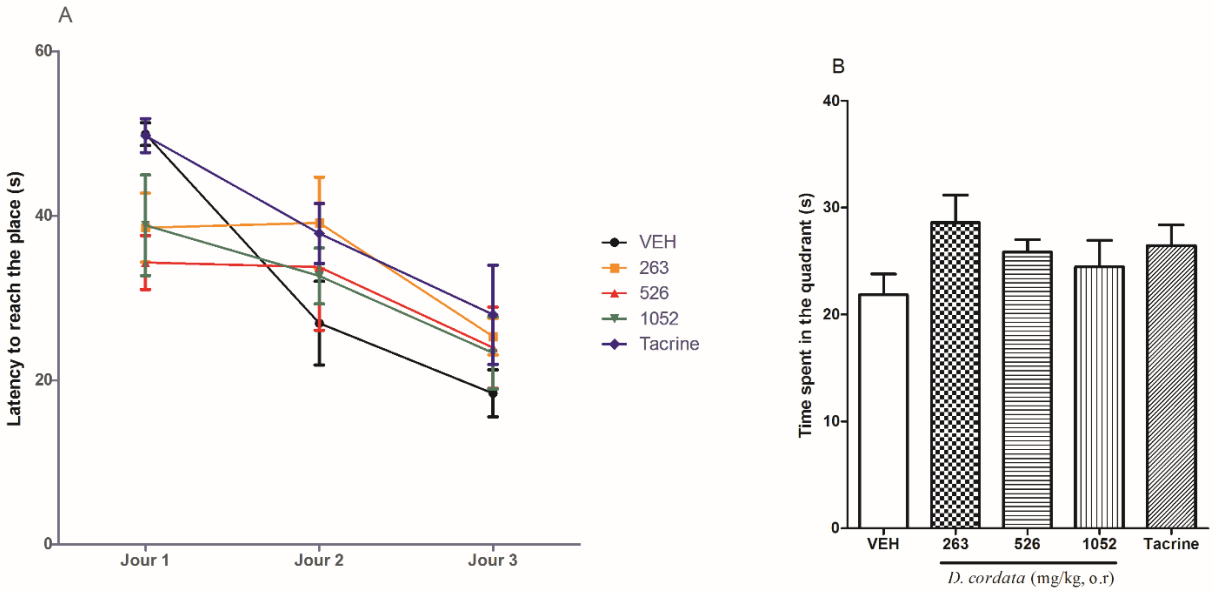

Figure 5. Effect of aqueous lyophilisate on learning and memory assessed in the MWM.
(A) Represents the latency to reach the hidden platform. (B) Represents the time spent in the target quadrant. N = 6. All the data are expressed as mean ±SEM. H_2O = Distilled water. VEH=Vehicle.

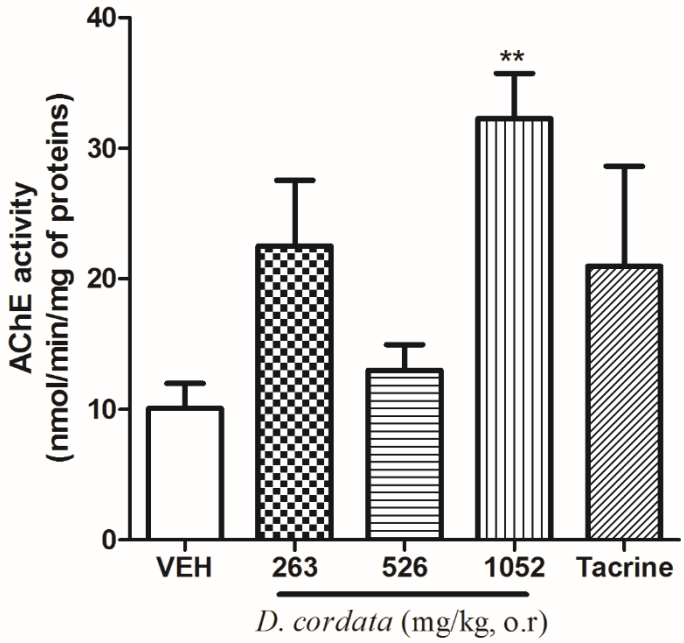

Figure 6. Effect of aqueous lyophilisate of *D. cordata* on acetylcholinesterase activity in hippocampus of mice
Data expressed as mean ± SEM. n = 4. ** p <0.01 compared to VEH. One-way ANOVA followed by StudentNewman keuls VEH= Vehicle. H_2O = Distilled water.

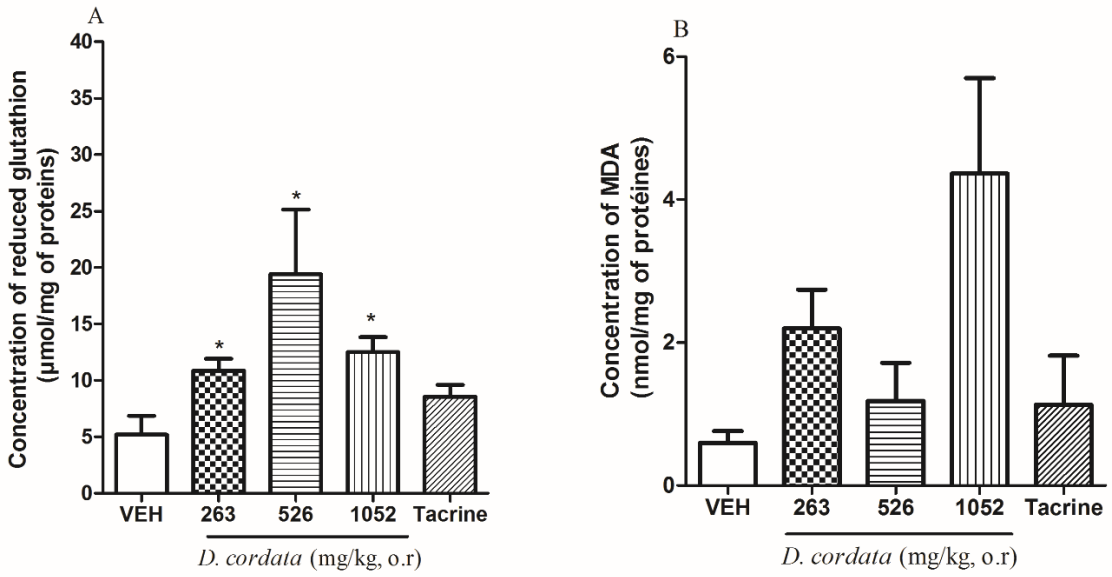

Figure 7. Effect of aqueous lyophilisate of *D. cordata* on reduced glutathione (A) and Malondialdehyde (B) concentrations in hippocampus of mice.
Data expressed as mean ± SEM. n = 4. * p <0.05compared to VEH, ANOVA followed by Student newman skeuls. VEH= Vehicule=distilled water.

Table 1. Qualitative phytochemistry of *Drymaria cordata*

Plant	Metabolites	Results
Drymaria cordata	Alkaloids	+
	Phenolic compounds	+
	Catechic tanin	+
	Flavonoids	-

+ = Present ; **-** = Absent

Conclusion

The aqueous lyophilisate of *D. cordata* has anti-amnestic properties against anterograde amnesia induced by scopolamine and enhance memory. The aqueous lyophilisate of *D. cordata* would improve learning and memorization, by acting on central cholinergic and glutamatergic signaling, and also by its antioxidant activity. These results justify at least in part its use in traditional medicine in the treatment of memory disorders (amnesia).

Abbreviations

AMPA: α-Amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid
ANOVA: Analysis of Variance
BHT: Butylated hydroxytoluene
DMSO: Dimethyl sulfoxide
DTNB: 5,5'-Dithiobis-(2-Nitrobenzoic) Acid
GSH: Reduced glutthione
MDA: Malondialehyde
MWM: Morris Water Maze
NMDA: N-Methyl-D-Aspartate
PBS: Phosphate Buffered Saline
SEM: Satndard Error Mean
TBA: Thiobarbituric acid
TCA: Tricloroacetic acid
VEH: Vehicle

Authors' Contribution

GTN conceived, designed, carried out and supervised the work, the data collection, analysis, and interpretation. She also arranged for the neurochemical assay and helped to draft the manuscript. TDK has also assisted in the design and carried out extract preparation, behavioural tests, and biochemical analysis. JY has performed the phytochemical characterization tests. MBA, CMN, AFF, assisted in the design of the work, the behavioural tests and the biochemical analysis. ENB has helped drafted the manuscript.

Acknowledgments

We would like to thank the Laboratory of Phytopharmacology and animal Physiology of the University of Dschang Cameroon and the Institute of Medical Research and Studies of Medicinal Plants, Yaounde, Cameroon for their assistance.

Conflict of interest

The authors declare that they have no competing interests.

Article history:

Received: 20 July 2020
Received in revised form: 04 August 2020
Accepted: 04 August 2020
Available online: 04 August 2020

References

1. OMS. 2013. Prévalence de la démence et des troubles cognitifs chez les personnes âgées en Afrique subsaharienne: etude systémique. *Bulletin de l'OMS*, 91(10):717-91.
2. Johnston B, Narayanasamy M. 2016. Exploring psychosocial interventions for people with dementia that enhance person hood and relate to legacy – an integrative review. *BioMed Central Geriatrics*, 16:1
3. Goetz P. 2017. Phytothérapie des troubles de mémoire. *Phytothérapie*, 15:159-63.
4. Ngoupaye TG, Pahaye DB, Ngondi J, Moto OCF, Ngo Bum E. (2017). *Gladiolus dalenii* lyophilisate reverses scopolamine-induced amnesia and reduces oxydative stress in rat brain. *Biomedecine and phytopharmacology*, 91:350-7.
5. Lapre E. 2010. Maladie d'Alzheimer et thérapie non médicamenteuses: Evaluation de la stimulation cognitive et de l'activité physique sur le fonctionnement executive. PhD Thesis, Université de Bordeaux, Bordeaux, p. 282.
6. El-Wahab AEA, Ghareeb DA, Sarhan EE, Abu-Serie MM, Demellawy MEA. 2013. *In vitro* biological assessment of *Berberis vulgaris* and its active constituent, berberine : antioxidants, anti-acetylcholinesterase, anti-diabetic and anticancer effects. *Complementary and alternative medicine*, 13:218.
7. Ngansop RN, Kegah LN, Barboni L, Azefack LT. 2014. *Drymaria cordata* (Linn.) Willd (caryophyllaceae): etnobotany, pharmacology and phytochemestry. *Advances in biologicalchemestry*, 4:160-7.
8. Pahaye BD, Ngo Bum E, Taïwé SG, Ngoupaye TG, Sidiki N, Moto OFC, Kouemou N, Njapdounke KSJ, Nkantchoua G, Kandeda A, Omam OJP, Mairaira V, Ojong JL. 2017. Neuroprotective and antiamnesiceffects of *Mitragyna inermis* Willd (Rubiacea) on scopolamine-induced memory impairment in mice. *Behavioural neurology* :1-11.
9. Ngoupaye TG, Yassi BF, Bahane NAD, Ngo Bum E. 2018. Combined corticosterone treatment and chronic restraint stress lead to depression associated with early cognitive deficits in mice. *Metabolic brain disease*, 23:421-31.
10. Nath C, Saxena G, Tyagi E, Agrawal R. 2009. Cholinergic influence on memory stages: A study on scopolamine amnesic mice. *Indian journal of pharmacology*, 41(4):192-6.
11. Vorhees CV, Williams MT. 2006. Morris Water maze: procedures for assessing spatial and related forms of learning and memory. *Nature Protocols*, 1(2):848-858.
12. Mishra RM, Sahoo, Pradhaan CS. 2017. Scopolamine-induced amnesia model: A possible anticholinergic mechanism with reversibility with statins and nootropic agents. *National journal of physiology, pharmacy and pharmacology*, 3(8):420-5.
13. Gallarda T, Loo H. 2004. Mémantine : une nouvelle stratégie thérapeutique dans le traitement des formes modérément sévères à sévères de la maladie d'Alzheimer. *International Journal Geriatry Psychiatry*, 30 (1):69-79.
14. Anik, Cloutier. 2009. Effet neuroprotecteur et modulation du système anti-oxydant dans le cerveau par l'acide linoléique conjugué. Institut national de la recherche scientifique, maitrise en science expérimentale de la santé, p. 112.
15. Guichardant M, Bacot S, Molière P, Lacarde M. 2006. Les biomarqueurs de la péroxydation lipidique. *Oiseeds and fats, crops and lipids*, 1(13):30-4.
16. De Fàtima O-SI, Pereira SR, Fernandes PA, Ribeiri AF, Pires RG, Ribeuro AM. 2015. Mild thiamine deficiency and chronic ethanol consumption modulate acetylcholinesterase activity change and spatial memory performance in a water maze task. *Journal of molecular* neurosciences, 55(1):217-26.
17. Laroche S. 2013. Apprentissage, mémoire et langage. *Société des* neurosciences :21-4.
18. Cooke SF, Bliss TV. 2006. Plasticity in the human central nervous system. *Epub*, 129(7):1659-73.
19. Meunier C. 2013. Etude de la neuromodulation des réseaux neuronaux du cortex. PhD Thesis, Université Paris-sud, Paris, p. 285.
20. Yan CH, Park HJ, Chen HB, Cho HJ. 2014. L'administration à long terme de la scopolamine interfère avec la prolifération, la différenciation et la migration de des cellules nerveuses dans le gyrus denté de l'hippocampe de souris adulte, mais ne provoque pas la mort cellulaire. *Neural regeneration research*, 9(19):1731-9.
21. Hussain G, Rasul A, Anwar H, Aziz N, Razzaq A, Wei W, Ali M, Li J, Li X. 2018. Role of plant derived alkaloids and their mechanism in neurodegenerative disorders. *International journal of biological sciences*, 14(3):341-57.
22. Bhuyan DJ, Basu A. 2017. Phenolic compounds: potential health benefits and toxicity. *Nature Protocols* :P27-59.