Phytochemical and Pharmacological Evaluation of 
Cyperus odoratus Extract

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Abstract
Cyperus odoratus (Family: Cyperaceae) is a 10 to 50 cm long perennial herb used as traditional 
medicinal plant in Bangladesh to treat various pathological conditions like piles, tumour and wound. 
The ethanolic extract of C. odoratus (COET) has been evaluated for different bioactivities, for 
example, antioxidant, analgesic, anthelmintic and cytotoxic activities. Antioxidant activity was 
investigated by DPPH free radical scavenging assay, analgesic activity was evaluated from ‘acetic acid 
induced writhing inhibition test’ in mice, anthelmintic activities was tested by ‘time of paralysis and 
death’ assays and cytotoxic activities was observed from the ‘brine shrimp lethality bioassay’. Total 
tannin and phenol contents were also measured by using Folin-Ciocalteu reagent. Phytochemical 
screening indicated that the presence of alkaloids, tannins, flavonoids, glycosides, proteins, gums, 
steroids and acidic compounds. In DPPH free radical scavenging assay the extract showed IC50 value 
of 8.05 μg/ml whereas the standard ascorbic acid showed 31.40 μg/ml. The total tannin and phenolic 
contents were found to be 3.35 and 1.68 mg GAE/100 g of dried extract, respectively. In acetic acid 
induced writhing assay, the extract showed 36.23 and 61.32% writhing inhibition at doses of 250 
mg/kg and 500 mg/kg body weight, respectively, whereas standard Diclofenac-Na (25 mg/kg) showed 
70.03% writhing inhibition. The plant extract showed anthelmintic activity in a dose dependant 
manner. COET also showed LD50 against brine shrimp nauplii at 11.344 μg/mL. After observing all 
preaminary biological data, it has been confirmed that the plant has antioxidant, analgesic, cytotoxic 
and anthelmintic properties.

Key words Cyperus odoratus, antioxidant, analgesic, anthelmintic, cytotoxic.

Introduction
Medicinal plants have long history of use by 
human being for the cure of various ailments dating 
back to primitive age, probably when people 
observed the animal behaviour to utilize certain 
plant’s parts during their sickness (Sofowara, 1982; 
Hill, 1989). Medicinal plants always have played a 
major role in human health development and in 
disease control and cure. In recent times, it has been 
estimated that at least 80% of world population is 
reliant on medicinal plants rather natural medicine 

sources to cure ailments and improve health (Kaur 
and Jaggi, 2010). The World Health Organization 
(WHO) also provided similar data at early 2000s 
(Alves and Rosa, 2005). Perhaps, it is the fact that 
natural products have more ‘drug like and biological 
characteristics’ than most of the synthetic drugs, with 
fewer side effects that make them suitable candidate 
for therapeutic use (Minhajur et al., 2011). Moreover, 
about 25% pharmaceutically formulated drugs are 
derived from natural origin (Islam et al., 2016). As 
expected, researches on natural products are 
increasing day by day. Bangladesh has wide range of 
tropical and agro growing conditions that are

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advantageous to introduce and domestication of new plant varieties (Hossain et al., 2013). It is a perfect place for C. odoratus to grow and they are common in here.

C. odoratus is a perennial grass-like sedge. It is a monocotyledonous graminoid flowering plant which belongs to Cyperaceae family. C. odoratus has fibrous root along with slender and scaly creeping rhizomes, arises singly from the triquetras tubers with dense tuft of 10 to 60 cm. It has grass-like leaves, having no hair but easily distinguishable from grass. This grass grows in tropical, subtropical and temperate regions. It is prevalent in North America, Japan, Korea and Russia (Maximowicz and Mém, 1859).

To elucidate the pharmacological activities of C. odoratus, three studies were commissioned recently. Three compounds, 3,4-dimethoxy benzoic acid (1), 4-hydroxybenzoic acid (2) and piceatannol (3) were isolated from the active ethyl acetate soluble fraction of C. odoratus and was investigated for antioxidant property using DPPH scavenging assay. (Lee et al., 2008). C. odoratus showed declined proliferation of human hepatocellular carcinoma (cell line used: Hep3B) by inducing apoptosis and arresting the G0/G1 phase of cell cycle (Pham et al., 2016). C. odoratus also gave 57.3% in-vitro pancreatic lipase inhibitory activity (Sharma et al., 2005). Traditionally, this grass is used to treat wounds, piles and tumors in Bangladesh by traditional medicinal practitioners (Rahmatullah et al., 2009).

Since, there is no reported data on analgesic, anthelmintic, cytotoxic activity, and antioxidant properties and total phenolic and tannin content of C. odoratus, the present study was undertaken to elucidate and evaluate these bioactivities to justify its medicinal use.

Materials and Methods

Plant collection and extraction: C. odoratus plant was procured from Sataish area of Gazipur district, Bangladesh in June, 2017 and experts at Bangladesh National Herbarium, Mirpur, Dhaka has identified it (voucher specimen no.: 45931). The whole plant was taken except the root and properly washed with fresh water to remove dirt, was shade dried for few days. The plant was then crushed into coarse powder with grinding machine. The powdered plant materials were stored at room temperature for further use. Five hundred gram of the dried-crushed materials were then soaked with about 1500 ml ethanol in an amber glass container. This mixture was occasionally shaken and stirred for 7 days and eventually was filtered with a piece of clean white cotton. Then it was again put through filtration using Whatman No. 1 filter paper. The filtrate was evaporated and dried at room temperature with continuous air flow. Total yield of COET was 2.05%.

Chemicals: Sodium carbonate and Folin-Ciocalteus’s reagent were obtained from Merck (Damstadt, Germany), potassium dichromate, gallic acid (GA), ascorbic acid (AA), AlCl₃, H₂SO₄, Nitric acid, NaOH, DMSO, EDTA, Diclofenac-Na, sodium nitrite, tween-80 and FeCl₃ were purchased from the Sigma Chemical Co.

Phytochemical screening: Standard chemical reagents were used to identify and categorize the chemical constitutes of COET using some positive control processes, for example, reducing sugar with Fehling’s Solution and Benedict’s reagent, combined reducing sugar with Fehling’s Solution, glycosides with NaOH solution, Protein-Xanthoprotein with HNO₃, flavonoids with concentrated H₂SO₄, dilute HCl and dilute NaOH, Tarpenoid with H₂SO₄, acidic compound with NaHCO₃ solution, alkaloid with Mayer’s and Dragendorff’s reagent, saponins with distilled water and tannin with FeCl₃ and K₂Cr₂O₇ solution (Ghani, 1995).

DPPH free radical scavenging assay: Quantitative antioxidant activity of COET was estimated by DPPH (2, 2-diphenyl-1-picrylhydrazyl) free radical scavenging assay (Choi et al., 2000). In this method, 0.004 % (w/v) DPPH solution was prepared in ethanol and 3 ml of it was mixed with 1 mL ethanolic crude extract at a different concentration. Subsequently, the mixture was vigorously shaken and kept in a dark place at room temperature for about 30 minutes. UV absorbance
was measured at 517 nm. Percentage of scavenging activity was measured by following equation:

\[
\% \text{ DPPH free radical scavenging activity} = \left[ \frac{(A_0 - A_1)}{A_0} \right] \times 100
\]

Here, \( A_0 \) is the absorbance of control, and \( A_1 \) is the absorbance of \( C. \) odoratus/positive control. The % scavenging activity was then plotted against log concentration and a graph for \( IC_{50} \) was calculated.

Estimation of total phenolics: Total phenolic content of COET was determined by Folin-Ciocalteu technique (Borah et al. 2011). 2 ml Folin-Ciocalteu reagent was diluted 10 times with 2 ml Na₂CO₃ (75 g/l) and water (1:10 v/v) and an aliquot of COET or positive control was mixed with this. To develop colour, the tubes were shaken for 15 seconds and then the mixtures were allowed to stand 20 minutes at room temperature. UV absorbance was measured at 750 nm. COET or positive control was evaluated at 0.1 mg/ml concentration. Gallic acid equivalent, GAE (mg of GA/g of dried plant extract) was used to express total phenolic content. Then a gallic acid standard calibration curve was developed with a positive control curve equation of \( y = 0.062x - 0.0153, R^2 = 0.982. \)

Determination of total tannins: Total tannin content of COET was determined by using Folin-Ciocalteu (FC) reagent (Marinova et al., 2005). To begin the process, 0.1 ml COET (positive control) was added to 0.5 ml FC reagent and 7.5 ml distilled water. This preparation was shaken and kept for 5 minutes. Then 1 ml 35% Na₂CO₃ solution was added by following a dilution with 10 ml distilled water. This preparation was then kept at room temperature for 30 minutes. UV absorbance was measured at 275 nm against blank after 30 minutes. Gallic acid equivalent, GAE (mg of GA/g of dried plant extract) was used to express total tannin content. Then gallic acid standard calibration curve was developed and positive control curve equation was \( y = 0.0209x - 0.0214, R^2 = 0.904. \)

Acetic acid induced writhing inhibition test: To assess the analgesic activity of COET, acetic acid induced writhing method was rendered on mice (Ahmed et al., 2004). Swiss-albino mice of any sex (n=5) weighing 25-40 g were taken as study subjects. All subjects were unfed for 2 hrs prior to commencing the experiment. Subjects were divided into four groups. 1% tween-80 solution in water (10 ml/kg) was given to Group-I as the control, Group-II received Diclofenac-Na as positive control at 25 mg/kg body weight dose. The other two groups, Groups-III and -IV were treated with COET dose of 250 and 500 mg/kg body weight, respectively. 30 minutes later, 0.7% acetic acid was intra-peritoneally injected into subject animals. 5 minutes later writhing number was counted for the period of 15 minutes.

Evaluation of anthelmintic activity: Anthelmintic activity of COET was investigated on live adult earthworm \( Pheretima posthuma \) (Ghosh et al., 2005). Four (4) different groups were made having four (4) parasites in each of them. COET concentrations of 25 and 50 mg/ml and standard solution (i.e., standard Albendazole) of 15 mg/ml were prepared in PBS. They were then transferred to petri dishes. 0.1% tween-80 in PBS was used to treat the control group. Every petri dish had four (4) parasites and their activities were observed. The paralysis time (i.e., when the parasites had no movement without robust shaking) and the death time (i.e., when the parasites did not show any movement or response upon vigorous shaking, treatment with warm water (50°C) or external stimuli) were recorded. As compared to control, the time required for paralysis and death of parasites were used to assess the anthelmintic activity of COET.

Brine shrimp lethality bioassay: Brine shrimp lethality bioassay was employed to evaluate the cytotoxic activity of COET (McLaughlin et al., 1998). \( Artemia \) was chosen to convey this test. Artificial sea water was produced by using 3.8% NaCl solution and the brine shrimp eggs were hatched for 1 day (24 hrs) to mature the shrimp (i.e., nauplii). Stock solution of 5 ml was serially diluted to make concentrations 320, 160, 80, 40, 20, 10 and 5 \( \mu \)g/mL. 5 ml stock solution of vincristine sulphate (positive control) was serially diluted to make concentrations 5, 2.5, 1.25, 0.625 and 0.325 \( \mu \)g/mL. Ten (10) different test tubes were taken and ten (10)
nauplii were taken in each of them with volume adjusted to 10 ml with sea water. The concentration of DMSO was kept at 10 μl/ml. After 1 day (24 hrs), the test tubes were checked against light to count the number of alive shrimps. Lastly, the LC₅₀ values were measured from Probit Analysis Chart. Probit Analysis Chart was done with “LdP line software” to measure the LC₅₀ values (Bauer et al., 1966).

Statistical analysis: All analyses were double checked and passed in two replications. Mean ± SEM was used to present data. All experimental parameters were evaluated for their significance level by correlation and regression analysis, the t-tests (P<0.05) was used. Microsoft Excel 2016 was used for both statistical analysis and graphical presentation.

Results
Phytochemical screening: Phytochemical screening of C. odoratus plant extract (COET) showed the presence of alkaloids, tannins, flavonoids, glycosides, proteins, gums, steroids and acidic compounds, which are summarized in Table 1.

Total phenolic and tannin content: Gallic acid equivalent was used to determine and express total phenolic and tannin contents of COET (Figure 2). Total phenolic and total tannin content were 1.68 g GAE/100 g and 3.35 g GAE/100 g, respectively of C. odoratus plant extract as represented in Table 2.

Table 1. Result of phytochemical screening of ethanol extract of C. odoratus.

<table>
<thead>
<tr>
<th>Phytochemical Group</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing sugar</td>
<td>-</td>
</tr>
<tr>
<td>Combined reducing sugar</td>
<td>-</td>
</tr>
<tr>
<td>Tannins</td>
<td>+</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>+</td>
</tr>
<tr>
<td>Saponin</td>
<td>-</td>
</tr>
<tr>
<td>Gums</td>
<td>+</td>
</tr>
<tr>
<td>Steroids</td>
<td>+</td>
</tr>
<tr>
<td>Alkaloids</td>
<td>+</td>
</tr>
<tr>
<td>Glycoside</td>
<td>+</td>
</tr>
<tr>
<td>Proteins</td>
<td>+</td>
</tr>
<tr>
<td>Acidic compounds</td>
<td>+</td>
</tr>
</tbody>
</table>

(+) = present; (-) = absent

Figure 1. Comparison of % inhibition vs. log concentration graph for standard (ascorbic acid) vs. Cyperus odoratus ethanolic extract.
**Analgesic activity:** COET exhibits a significant inhibition of writhing reflex as signified by the result of analgesic activity. COET reduced writhing by 36.23% and 61.32% at 250 mg/kg and 500 mg/kg doses, respectively. The positive control (Diclofenac-Na) showed 70.03% writhing inhibition at a dose of 25 mg/kg body weight (Table 3).

**DPPH free radical scavenging activity:** Quantitative antioxidant activity of COET was performed by DPPH free radical scavenging assay, where the IC₅₀ value for scavenging free radicals of the extract was 8.05 µg/ml, whereas standard ascorbic acid showed the IC₅₀ value of 31.40 µg/ml (Figure 1).

**Table 2. Phenolic and tannin content of ethanol extract of C. odoratus.**

<table>
<thead>
<tr>
<th>Polyphenolic compounds</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total phenol</td>
<td>1.68± 0.001</td>
</tr>
<tr>
<td>Total tannin</td>
<td>3.35 ± 0.001</td>
</tr>
</tbody>
</table>

Here, each value represents the average of two analysis ± standard error of mean expressed in terms of gm GAE /100 gm dried plant extract.

**Anthelmintic activity:** The anthelmintic activity of COET and standard Albendazole are shown in Table 4 and Figure 3. COET caused paralysis at approximately 70 minute and 44 minute at concentrations of 25 and 50 mg/ml, whereas the approximate death times were observed at 72 minute and 46 minute at respective concentration. Standard Albendazole also showed paralysis at around 18 min and death at 26 minute for 15 mg/ml concentration. Extract showed more effectiveness at higher concentration (50 mg/ml) against *Pheretima posthuma*.

**Brine Shrimp Lethality Bioassay:** The percent mortality of the nauplii caused by both the plant extract and the positive control (Vincristine Sulphate) is expressed in Figure 4. The LD₅₀ of sample as well as positive control was calculated by Probit analysis software (LD₅₀ Line software, USA). The LD₅₀ for COET was found to be 11.344 µg/ml whereas the positive control (Vincristine Sulphate) showed LD₅₀ at 0.7158 µg/ml (Table 4).

**Table 3. Analgesic activity of COET in acetic acid induced pain in mice model.**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dose (mg/kg)</th>
<th>Mean writhes (no)</th>
<th>% Inhibition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1% Tween-80</td>
<td>23.4 ± 3.14</td>
<td>---</td>
</tr>
<tr>
<td>Diclofenac-Na</td>
<td>25</td>
<td>7 ± 1.04*</td>
<td>70.03</td>
</tr>
<tr>
<td>Extract 250</td>
<td>250</td>
<td>16.6 ± 1.4**</td>
<td>36.23</td>
</tr>
<tr>
<td>Extract 500</td>
<td>500</td>
<td>11.6 ± 0.7***</td>
<td>61.32</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± SEM. SEM= Standard error for mean. n = number of mice (5), *P = 0.0011, **P = 0.0844 and ***P = 0.0064 vs. control, Student’s t-test.
Table 4. Anthelmintic activity of COET.

<table>
<thead>
<tr>
<th>Treatments Concentration (mg/ml)</th>
<th>Worm No.</th>
<th>Time taken for paralysis (min)</th>
<th>Mean time of paralysis (min ±SD)</th>
<th>Time taken for death (min)</th>
<th>Mean time of death (min. ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control 0.1% Tween-80 in PBS</td>
<td>C1</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C2</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C3</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C4</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Albendazole 15</td>
<td>S1</td>
<td>15.25</td>
<td></td>
<td>23.32</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S2</td>
<td>18.45</td>
<td></td>
<td>26.12 ± 2.22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S3</td>
<td>21.11</td>
<td>18.01 ± 2.45</td>
<td>28.22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S4</td>
<td>17.21</td>
<td></td>
<td>25.39</td>
<td></td>
</tr>
<tr>
<td>Extract 25</td>
<td>T1</td>
<td>65.4</td>
<td></td>
<td>67.26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>68.48</td>
<td></td>
<td>71.19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T3</td>
<td>73.19</td>
<td>70.19 ± 3.55</td>
<td>74.21</td>
<td>72.38 ± 3.60</td>
</tr>
<tr>
<td>Extract 50</td>
<td>T1</td>
<td>30.21</td>
<td></td>
<td>31.42</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>44.47</td>
<td></td>
<td>47.49</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T3</td>
<td>46.28</td>
<td>44.04 ± 9.77</td>
<td>49.45</td>
<td>46.40 ± 10.84</td>
</tr>
<tr>
<td></td>
<td>T4</td>
<td>53.56</td>
<td></td>
<td>57.25</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3. Determination of anthelmintic activity of COET through paralysis time and death time.

Table 5. LD\textsubscript{50} for extract and standard with lower and upper limit.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Conc. (µg/ml)</th>
<th>Lower limit (µg/ml)</th>
<th>Upper limit (µg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extract</td>
<td>11.344</td>
<td>6.1642</td>
<td>16.7322</td>
</tr>
<tr>
<td>Standard</td>
<td>0.7158</td>
<td>0.4123</td>
<td>1.0293</td>
</tr>
</tbody>
</table>
Figure 4. Graphical representation of brine shrimp lethality bioassay and LD$_{50}$ for COET (A) and positive control (i.e., Vincristine sulphate) (B) by LdP line software.

Discussion

Antioxidant activity is one of the most important pharmacological properties of plants. To test the free radical scavenging activity or the antioxidant activity of plant extracts and foods a stable free radical, DPPH is widely used (Porto et al., 2000; Soares et al., 1997), which is readily scavenged by antioxidants (Lu and Yeap Foo, 2001). The scavenging ability of the extract was found to be concentration-dependent and expressed as IC$_{50}$ (i.e., sample concentration required to decrease the initial concentration of DPPH by 50%) values. A higher antioxidant activity is indicated by a lower IC$_{50}$ value. In this study, the ethanol extract of C. odoratus showed an acceptable IC$_{50}$ value, which is compared to standard ascorbic acid (Figure 1) and it indicates the presence antioxidant components in the plant extract. The result also suggests that the plant contains phytochemical constituents that are capable of donating hydrogen in order to protect the cell from potential damage.

Plant phenolic compounds such as flavonoids, phenolic acids, and tannins present in the fruits and vegetables have potential biological activities including antiatherosclerotic, anticancer and anti-inflammatory activities and such activities might be associated with their antioxidant properties (Chung et al., 1998). Plant phenolic compounds containing hydroxyl groups have a good scavenging capacity (Kahkonen et al., 1999; Naczk and Shahidi, 2004). The result (1.68 g GAE/100g of dried extract) proved that the extract possesses phenolic compounds containing hydroxyl groups.

Bitter plants contain polyphenols such as tannins, which have astringent properties and thus they can bind to protein molecules to precipitate or shrink them. Tannins contain sufficient hydroxyl groups and other free radicals for instance carboxyl and they bind proteins and other macromolecules. These free radicals protect cell damage (AfifyAel-M. et al., 2012). Some studies specify that tannins are effective against ulcerated or inflamed tissues and they also possess a good anticancer activity (Ruch et al., 1989; Motar et al., 1985). Our studied result suggests that the extract contains considerable amount of tannins that may be a source of free radicals to protect the cell from death and satisfy the possible mechanism of plants’ free radical scavenging properties.

Pathological condition such as tissue injury induced pain results in the local release of prostaglandins, cytokinins, leukotrienes etc. that act on the nerve terminals in both activating them directly and enhancing their sensitivity to other stimulations (Kanodia and Das, 2008; Goldstein et al., 1970). Intraperitoneal administration of acetic acid produces pain by consequent abdominal writhing due to the release of mediators like prostaglandin E2 and other lipoxygenase products (Sulaiman et al., 2008). There are mainly two
prostaglandins, prostacyclines (PG12) and prostaglandin E (PG-E), which are responsible for pain sensation due to the excitation of Aδ-nerve fibers (Lourens et al., 2004). Thus, ethanol plant extract of C. odoratus may produce analgesic activity due to the inhibition of prostaglandin synthesis by blocking of lipoxygenase and cyclooxygenase activities. In this study, extract of C. odoratus showed a comparable writhing inhibition to Diclofenac-Na, standard analgesic drug. The extract showed analgesic activity in a dose dependent manner.

The extracts showed anthelmintic activity in a dose-dependent manner. Evaluation of anthelmintic activity was compared with reference standard Albendazole. Phytochemical screening revealed that the presence of tannins along with other chemical constituents contained within them. Tannins have been reported to be responsible for anthelmintic activities (Niezen et al., 1995; Shrestha et al., 2009), as they can cause the death of parasites upon binding to free proteins in the gastrointestinal tract of host animal (Athanasiadou et al., 2001) or glycoprotein on the cuticle of the parasite (Thompson et al., 1995).

The brine shrimp lethality bio assay is a rapid, inexpensive and simple bioassay for testing plant extract’s bioactivity, which in most cases correlates reasonably well with cytotoxic and anti-tumour properties (McLaughlin et al., 1993). This assay was proposed by Michael et al. in 1956 and developed by Vanhaecke and co-workers in 1981 and improved by Sleet and Brendel in 1983. The brine shrimp lethality bioassay has been widely used in the primary screening of the crude extracts and the isolated compounds to assess the toxicity towards brine shrimps (Meyer et al., 1982). This assay is recommended for the detection of antitumour and pesticidal compounds due to its simplicity and low cost (Mazid et al., 2008). The assay is a useful tool for preliminary assessment of toxicity. Fungal toxins, plant extract toxicity, heavy metals, pesticides and cytotoxicity can be detected with the help of this assay (Harwig and Scott, 1971; McLaughlin et al., 1991; Pelka et al., 2000). Bioactive compounds can be isolated from plant extracts using brine shrimp assay (Sam, 1993). The significant lethality of brine shrimp due to extracts of Cyperus odoratus is an indicative of the presence of potent cytotoxic components.

Conclusion

The present study reveals that the ethanol extract of C. odoratus plant possess antioxidant activity and significant analgesic activity as well as cytotoxic and anthelmintic activity which justifies its uses in folk medicine. These preliminary studies do not describe the actual mechanism for various pharmacological actions reported in this manuscript. However, more extensive studies (including isolation and identification of active compounds and in-depth pharmacological mechanistic assays) are required to determine the exact mechanism of action of the extract and its active compound(s) to authenticate it as a potent antioxidant, analgesic, cytotoxic and anthelmintic agent.

Declaration of interest

The authors declare no conflict of interest.

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Reference


