Rumex dentatus could be a potent alternative to treatment of microbial infections and of breast cancer

Riffat Batool, Ejaz Aziz, Hina Salahuddin, Javed Iqbal, Saira Tabassum, Tariq Mahmood

Riffat Batool, University Institute of Biochemistry and Biotechnology, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi, Rawalpindi, Punjab 46000, Pakistan
Ejaz Aziz, Department of Botany, Government Degree College Khanpur, Haripur 22650, Pakistan
Hina Salahuddin, Department of Zoology, University of Okara, Okara 56300, Pakistan
Saira Tabassum, National University of Technology, School of Applied Sciences and Humanities, National University of Technology, Islamabad 42000, Pakistan
Javed Iqbal, Tariq Mahmood, Department of Plant Sciences, Faculty of Biological Sciences, Quaid-i-Azam University, Islamabad 45320, Pakistan
Correspondence to: Dr. Tariq Mahmood, Department of Plant Sciences, Faculty of Biological Sciences, Quaid-i-Azam University, Islamabad 45320, Pakistan
pk, tmahmood.qau@gmail.com
Telephone: +92-51-90643050
Accepted: December 25, 2018

Abstract

OBJECTIVE: To investigate the phytochemicals and in vitro antioxidant, antimicrobial and cytotoxic potential of Rumex dentatus (R. dentatus) leaf extracts.

METHODS: The total phenolics and flavonoids content of R. dentatus extracts were evaluated by the Folin-Ciocalteu and aluminum chloride colorimetric methods respectively. Antioxidant potential of studied plant extracts was assessed through 2,2-diphenyl-1-picrylhydrazyl radical scavenging capacity, total reducing power and total antioxidant methods. Moreover, antibacterial and antifungal capacity was also evaluated by disc diffusion method against six clinically isolated multi-drug resistant bacterial strains as well as six fungal isolates. Further, cell cytotoxicity was also evaluated through 3-(4, 5-dimethylthiazolyl-2)-2, 5-diphenyltetrazolium bromide assay.

RESULTS: Ethanol extract showed highest total phenolic [(38.9 ± 1.5) µg gallic acid equivalent/mg] and total flavonoids [(17.2 ± 1.9) µg quercetin equivalent/mg] contents. Antioxidant assays indicated that ethanol and methanol extracts possess potent antioxidant potential. Moreover, it was observed that ethanol and hexane extracts have the potential to inhibit most of the tested multi-drug resistant bacterial strains while methanol, chloroform and hexane extracts could inhibit the growth of pathogenic fungal strains successfully. Among all the studied extracts, ethanolic extract showed highest cytotoxicity against MCF-7 cell line then Hep-2 and DU-145 cell lines by MTT assay with lowest IC50 of 47.3 µg/mL.

CONCLUSION: These results suggest that R. dentatus could be a potent alternative candidate for treatment of microbial infections and for breast cancer treatment.

© 2019 JTCM. All rights reserved.

Keywords: Rumex; Antioxidants; Anti-infective agents; Drug resistant, multiple; Cytotoxins

INTRODUCTION

Despite the fact that a number of new antibiotics are produced by pharmaceutical industries, increased resistance of pathogens by indiscriminate use of these drugs has been observed. Therefore, requirement for
antimicrobial drugs possessing broad spectrum of activities from natural compounds is increasing daily. Plant extracts and their phytoconstituents have always been an important source of therapeutic agents. The highly reactive free radicals in biological systems from a wide variety of sources can initiate degenerative diseases by oxidation of many molecules like nucleic acids, proteins and lipids present in the system. Available scientific data form a large pool of evidence to prove that antioxidants can reduce and treat the chronic ailments e.g. cancer and heart diseases. The significant characteristic of an antioxidant lies in its capability to trap free radicals such as peroxide, lipid peroxyl or hydroperoxide which in turn hinder the oxidation process and control the degenerative diseases.

Cancer, being the second leading cause of deaths globally, has caught the researcher’s attention to search for new prognosis approaches and to find more effective treatment methods. Several methods for cancer treatment including chemotherapy are often unsuccessful due to antagonistic reactions, the dispersed resistance of cancer cells to apoptosis, drug resistance and non-selectivity of some types of medicines. In this manner, the interest in drug development from natural compounds has emerged which can overcome the problem stated. Additionally, it may have reduced side effects and it can be proved effective against various types of cancer. Medicinal plants have been extensively used as a safe substitute for various synthetic medications to treat various ailments including multiple types of inflammatory diseases like cancer and various infections. Biological activity of medicinal plants stems from their secondary metabolites. It has caught the attention of the researcher’s in cancer treatment due to their positive role against proliferation and angiogenesis.

In this study Rumex dentatus (R. dentatus) was selected for evaluation of its biological potential in an effort to expand the spectrum of novel antimicrobial and anticancer potential from natural herbal resources.

MATERIALS AND METHODS

Plant collection
The plant sample of R. dentatus was collected in the month of Aug-Sep from Khyber Pakhtunkhwa, Pakistan. The collected plant sample was identified and its authenticated voucher specimen (HPBMBL-16-023) was deposited in the Herbarium of Plant Biochemistry and Molecular Biology Laboratory, Quaid-i-Azam University, Islamabad.

Preparation of extracts
The collected plant material was thoroughly washed with running tap water followed by drying at room temperature under shade. The dried plant sample was ground to powder form and was maintained in a tightly closed container until used for extract formation. The leaf crude extracts of R. dentatus were prepared in five different solvents with range of polarity by soaking 25 g plant material in 250 mL of methanol (RM), ethanol (RE), benzene (RB), chloroform (RC) and n-hexane (RH) for one week with irregular shaking. The mixtures were filtered through Whatman filter paper No. 1 and filtrate was concentrated in a rotary evaporator (Rotavapor R-200 Buchi, Switzerland) at a temperature of 45 °C. The residue was again soaked in respective solvents and process repeated thrice. All the extract samples were kept at −20 °C until further use.

Functional components assays
The total phenolic contents (TPC) of extracts were measured following spectrophotometric Folin-Ciocalteu method. From extracts stock solution, 20 µL of each sample was combined with Folin-Ciocalteu reagent (90 µL) in corresponding wells of 96 well plates. After five minutes of incubation at room temperature, 90 µL of sodium carbonate (7.5 %) was mixed with the reaction mixture in wells of plate. The absorbance was recorded at 630 nm using microplate reader (Biotech) and taking gallic acid as a standard. The results were envisioned in µg gallic acid per mg of extract (µg GAE/mg extract). The selected extracts were also analyzed for their total flavonoid contents using a previously reported aluminium chloride colorimetric method, taking quercetin as a standard. A volume of 20 µL from each extract sample solution was combined with 10 µL of potassium acetate (1 M), 10 µL of 10 % aluminium chloride, and 160 µL of distilled water. After 30 min of incubation at room temperature, the absorbance was recorded at 415 nm. The results were expressed in µg quercetin per mg of extract (µg QE/mg extract).

Antioxidant activities
Radical-scavenging activity-DPPH assay: The antioxidant properties were evaluated by 2, 2-diphenyl-1-picrylhydrazyl (DPPH) free radical using a slightly modified method. Each extract sample was initially analyzed spectrophotometrically at 513 nm using a concentration of 200 µg/mL and the extracts revealing worthy antioxidant activity (≥50%) were further examined to find IC₅₀ values using lower concentrations. % antioxidant activity of test extract = (1−A₅₃/A₅₃) × 100 A₅₃ is the absorbance of extract sample; B₅₃ is the absorbance of reagent with negative control. Ascorbic acid served as positive control.

Total antioxidant capacity assessment: The antioxidant activity of extracts was also estimated by the phosphomolybdenum technique as examined previously. Briefly, test extract (100 µL from 4 mg/mL) was diluted with 900 µL reagent containing sulphuric acid (0.6 M), ammonium molybdate (4 mM) and sodium phosphate (28 mM). Following 90 min incubation at 95 °C, reaction samples were allowed to cool at room temperature and spectrophotometrically observed at 695 nm.
data generated was measured as ascorbic acid equivalents (µg AAE/mg extract).

**Reducing power**
The reducing power of each extract was assessed through potassium ferricyanide method. Briefly, a volume of 400 µL of 1% potassium ferricyanide and 400 µL of phosphate buffer (0.2 mol/L, pH 6.6) was mixed with 200 µL of each test samples. The mixture was kept at 50 °C for 20 min and mixed with 400 µL of trichloroacetic acid (10%). In next step, centrifugation was done at 3000 rpm for 10 min at room temperature. Then 500 µL distilled water was added in 500 µL of reaction solution and 0.1% of ferric chloride (100 µL) and absorbance was recorded at 700 nm. The reducing power of samples was expressed as ascorbic acid equivalent (µg AAE/mg extract).

**Antibacterial assay**
The plant extracts were also studied for antibacterial potency against six clinically isolated MDR bacterial strains namely Klebsiella pneumoniae (K. pneumoniae), Methicillin-resistant Staphylococcus aureus, Escherichia coli, Salmonella typhi, Serratia marcescens and Pseudomonas aeruginosa obtained from IBGE Islamabad Pakistan while Enterobacter aerogenes ATCC# 13048 and Staphylococcus aureus ATCC# 6538 were used as reference sensitive strains. Disc diffusion method was employed to assay antibacterial potency. DMSO was used as negative control. Minimum inhibitory concentrations were recorded for only those extracts which had an inhibition zone equal to or greater than 10 mm by microbroth dilution approach with slight modifications.

**Antifungal assay**
The samples under investigation were also investigated for antifungal activity against six fungal isolates i.e. Candida albicans (FCBP-478), Aspergillus flavus (FCBP-0064), Aspergillus niger (FCBP-0198), Aspergillus fumigatus (A. fumigatus) (FCBP-66), Muco r species (FCBP-0300) and Fusarium solani (FCBP# 0291) by agar disc diffusion method. DMSO and Clotrimazole served as negative and positive controls respectively. MIC was resolute by microdilution broth method. Clotrimazole served as negative and positive controls (3-5 times). Antifungal assay

<table>
<thead>
<tr>
<th>Plant extract</th>
<th>TPC (µg GAE/mg±SD)</th>
<th>TFC (µg QE/mg±SD)</th>
<th>TRP (µg AAE/mg±SD)</th>
<th>TAC (µg AAE/mg±SD)</th>
<th>DPPH (% Inhibition±SD)</th>
<th>IC_{50} (µg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM</td>
<td>29.1±1.1</td>
<td>11.6±1.6</td>
<td>26.9±1.8</td>
<td>23.5±2.1</td>
<td>87.5±1.5</td>
<td>22.50</td>
</tr>
<tr>
<td>RE</td>
<td>38.9±1.5</td>
<td>17.2±1.9</td>
<td>29.7±1.3</td>
<td>16.6±1.4</td>
<td>89.3±1.5</td>
<td>19.50</td>
</tr>
<tr>
<td>RB</td>
<td>25.4±2.2</td>
<td>2.1±0.6</td>
<td>12.6±1.3</td>
<td>11.6±1.7</td>
<td>58.6±1.2</td>
<td>38.46</td>
</tr>
<tr>
<td>RC</td>
<td>15.2±2.1</td>
<td>9.2±2.3</td>
<td>17.4±2.6</td>
<td>14.6±2.5</td>
<td>42.1±2.7</td>
<td>40.25</td>
</tr>
<tr>
<td>RH</td>
<td>9.3±1.7</td>
<td>1.6±0.8</td>
<td>10.2±2.5</td>
<td>9.8±2.7</td>
<td>38.4±3.0</td>
<td>38.42</td>
</tr>
</tbody>
</table>

Notes: SD: standard deviation; RM: R. dentatus methanol; RE: R. dentatus ethanol; RB: R. dentatus benzene; RC: R. dentatus chloroform; RH: R. dentatus n-hexane; TPC: total phenolic contents; TFC: total flavonoid contents; TRP: total reducing power; TAC: total antioxidant capacity; DPPH: 2,2-diphenyl-1-picrylhydrazyl; IC_{50}: half maximal inhibitory concentration.

**Cytotoxicity analysis**
Breast cancer cell line (MCF-7), prostate cancer cell line (DU-145), human laryngeal carcinoma cell line (Hep-2) and a normal cell line (HCEC) were seeded in 96 well plate at a density of 1 × 10^4 per mL and incubated for 24 h at 37 °C under 5% CO₂. Then the medium was replaced by different concentrations of plants extract followed by incubation for 48 h. After 24 h of treatment, 50% inhibitory concentrations (IC_{50}) was determined by MTT assay. A volume of 10 µL of 3-(4,5-dimethyl-2-thiazolyl)-2,5-diphenyl-tetrazolium bromide was added to cells and incubated for 4 h. Then 100 µL of solubilization solution (DMSO) was added and absorbance was recorded at 570 nm using enzyme-linked immunosorbent assay plate reader. The cytotoxic effect of extracts prepared in different solvents was calculated based on the following formula:

% inhibitory concentrations (IC_{50}) = (1-Optical density of treated cell/ Optical density of control) × 100

**RESULTS**

**Functional components and antioxidants**
Among R. dentatus fractions, ethanolic extract (RE) presented highest TPC (38.9 ± 1.52) µg GAE/mg and order decrease as RM > RB > RC > RH. Highest flavonoids were also observed in its RE sample (17.2 ± 1.9) µg QE/mg while RH was found with lowest total flavonoid contents (TFC) (1.6 ± 0.8) µg QE/mg (Table 1). Maximum percentage DPPH scavenging potential of R. dentatus extracts was recorded as descendent order RE > RM> RB> RC> RH with values 89.27% (% IC_{50} = 19.5 µg/mL), 87.54% (% IC_{50} = 22.5 µg/mL), 58.65 % (% IC_{50} = 38.46 µg/mL), 42.13% (% IC_{50} = 40.25 µg/mL) and 38.42 % (% IC_{50} = 38.42 µg/mL) respectively (Table 1). Correlation between the radical scavenging capability and the total phenolic content of R. dentatus was found as R = 0.8155. Total antioxidant capacity (TAC) of R. dentatus was observed in descending order as RM > RE > RC > RB > RH having values of (23.5 ± 2.1), (16.6 ± 1.4), (14.6 ± 2.5), (11.6 ± 1.7) and (9.8 ± 2.7) µg AAE/mg respectively (Table 1) with R between antioxidant capacity and total phenolic was recorded as 0.7524. The ethanolic extract...
Antimicrobial evaluation
Ethanolic extract of R. dentatus showed significant antibacterial potential by giving highest zone of inhibition (ZOI) against K. pneumoniae 25.0 ± 1.4 mm (MIC: 25 µg/mL) (Figure 1) followed by E. aerogenes 19.0 ± 1.3 mm (MIC: 50 µg/mL), S. aureus 17.0 ± 2.5 mm (MIC: 50 µg/mL) and E. coli 15.0 ± 2.4 mm (MIC: 75 µg/mL). RH extract also exhibited good activity against K. pneumoniae 18.0 ± 1.4 mm (MIC: 50 µg/mL), E. coli 17.0 ± 2.5 mm (MIC: 50 µg/mL), MRSA 15.0 ± 2.5 mm (MIC: 75 µg/mL), E. aerogenes 15.0 ± 2.5 mm (MIC: 75 µg/mL), S. aureus 15.0 ± 1.1 mm (MIC: 75 µg/mL) and P. aeruginosa 14.0 ± 1.0 mm (MIC: 75 µg/mL). Benzene extract (RB) remained least effective for all the strains by depicting weak zone of inhibitions for most of MDR strains, RC had obvious effect for MRSA 17.0 ± 1.0 mm (MIC: 50 µg/mL), E. aerogenes 16.0 ± 2.3 mm (MIC: 50 µg/mL), S. marcescens 15.0 ± 1.9 mm (MIC: 75 µg/mL), K. pneumonia 14.0 ± 1.3 mm (MIC: 75 µg/mL), E. coli 12.0 ± 1.2 mm (MIC: 75 µg/mL) and S. aureus 12.0 ± 1.6 mm (MIC: 75 µg/mL). RM showed highest antibacterial potential for K. pneumoniae 16.0 ± 1.0 mm (MIC: 50 µg/mL), S. aureus 16.0 ± 1.5 mm (MIC: 50 µg/mL) and P. aeruginosa 13.0 ± 1.9 mm (MIC: 75 µg/mL) (Table 2).

The inhibitory activity of R. dentatus extracts in different solvents presented significant variation in fungal growth inhibition. The methanol extract (RM) of R. dentatus was found with most pronounced effect against A. fumigatus 17.0 ± 1.3 mm (MIC: 50 µg/mL) (Figure 2) and A. niger 17.0 ± 1.6 mm (MIC: 50 µg/mL) (Figure 3) followed by M. species 15.0 ± 0.5 mm (MIC: 75 µg/mL) and A. flavus 14.0 ± 0.5 mm (MIC: 75 µg/mL). RE showed significant resistance only for M. species 15.0 ± 1.6 (MIC: 75 µg/mL), while RH sample presented considerable inhibition for A. flavus 16.0 ± 1.6 mm (MIC: 50 µg/mL). RB and RC could not produce potent effect for fungal growth inhibition (Table 3). DMSO and Clotrimazole were used as negative and positive controls respectively.

Effect of R. dentatus extracts on MCF-7, DU-145, Hep-2 cancer cell lines
Different concentrations of the extracts were used and dose-dependent growth inhibition of treated cancerous cells was observed at 48 h treatment. The mean ICso of all the samples for cells mortality is given in Table 4. Maximum antiproliferative activity was obtained by ethanol, benzene and chloroform extracts against breast cancer MCF-7 cell line with lowest ICso at al-

Figure 1 Antibacterial activity of Rumex dentatus ethanol extract against Klebsiella pneumoniae

most equal concentrations as 47.3, 49 and 48 µg/mL respectively.

Benzene and chloroform extracts also inhibited prostate cancer cells (DU-145) proliferation at relatively lower ICso as 94 µg/mL and 99 µg/mL respectively while methanol (123 µg/mL) and ethanol (128 µg/mL) extracts were more potent to inhibit proliferation of hep-2 cells. All the extracts were non-cytotoxic for HCEC normal cell line. Overall, MCF-7 cell line showed most sensitivity among all tested cancerous cell lines to extracts of R. dentatus with lowest ICso values.

DISCUSSION
Flavonoids and phenolics have been known for their free radical scavenging activity as they donate hydrogen molecules to free radicals; therefore they act as antioxidants. The possible role of phenolics and flavonoids in the inhibition of free radicals provides basis for the content quantification in R. dentatus. Previously, Elzaawely et al analyzed aqueous, ethyl acetate and hexane fractions of R. dentatus for TPC and found the greatest amount in ethyl acetate and lowest in hexane. Their findings support our results as methanol and ethanol extracts of R. dentatus recorded higher values of TPC and TFC than non-polar solvents. The results demonstrate that RM and RE extracts of R. dentatus showed the highest scavenging activity in DPPH assay than the other plant extracts which may be attributed
Table 2 Antibacterial activity of R. dentatus extracts against MDR bacterial strains and ATCC reference strains

<table>
<thead>
<tr>
<th>Extracts solvent</th>
<th>K. pneumoniae</th>
<th>P. aeruginosa</th>
<th>S. typhi</th>
<th>S. marcescens</th>
<th>E. coli</th>
<th>MRSA</th>
<th>ATCC E. aerogenes</th>
<th>ATCC S. aureus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ZOI ± SD (µg/mL)</td>
<td>MIC ± SD (µg/mL)</td>
<td>ZOI ± SD (µg/mL)</td>
<td>MIC ± SD (µg/mL)</td>
<td>ZOI ± SD (µg/mL)</td>
<td>MIC ± SD (µg/mL)</td>
<td>ZOI ± SD (µg/mL)</td>
<td>MIC ± SD (µg/mL)</td>
</tr>
<tr>
<td>RM</td>
<td>16.0 ± 1.0</td>
<td>50</td>
<td>13.0 ± 1.9</td>
<td>75</td>
<td>-</td>
<td>-</td>
<td>6.0 ± 1.0</td>
<td>-</td>
</tr>
<tr>
<td>RE</td>
<td>25.0 ± 1.4</td>
<td>25</td>
<td>-</td>
<td>-</td>
<td>9.0 ± 1.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RB</td>
<td>7.0 ± 1.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9.0 ± 1.9</td>
<td>-</td>
<td>9.0 ± 1.6</td>
<td>-</td>
</tr>
<tr>
<td>RC</td>
<td>14.0 ± 1.3</td>
<td>75</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15.0 ± 1.9</td>
<td>75</td>
</tr>
<tr>
<td>RH</td>
<td>18.0 ± 1.4</td>
<td>50</td>
<td>14.0 ± 1.9</td>
<td>75</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DMSO</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes: RM: Rumex dentatus (R. dentatus) methanol; RE: R. dentatus ethanol; RB: R. dentatus benzene; RC: R. dentatus chloroform; RH: R. dentatus n-hexane; DMSO: dimethyl sulfoxide; -: no zone of inhibition; ZOI: zone of inhibition and MIC: minimum inhibitory concentration. Experimental data is articulated as mean ± standard deviation (SD) (n = 3).

Figure 3 Antifungal activity of Rumex dentatus methanol extract against Aspergillus niger.}

Figure 4 Antifungal activity of Rumex dentatus methanol extract against Aspergillus fumigatus.
In the present research work, extracts of R. dentatus showed significant results against MDR bacterial strains and pathogenic fungal strains. Results showed that ethanol sample (RE) of R. dentatus proved as significant potent extract against most of the tested MDR bacterial strains. RM was successful to inhibit higher number of tested fungal strains. N-hexane extract also showed good results for both bacterial and fungal growth inhibition. However, benzene and chloroform indicated moderate antimicrobial activity. This may also be attributed to the presence of soluble phenolic and polyphenolic compounds. As R. dentatus possessed significant effect against MDR bacterial isolates and fungal pathogens. This suggests that R. dentatus could be a good candidate for isolation of antimicrobial agents.

In the present study, MTT assay was conducted to infer the anti-cancer potential of the studied plant extracts against various cancer cell lines. Among all the studied cancer lines, ethanolic extract showed the highest anti-cancer potential against MCF-7 cancer cell line. It has been deduced that all the selected extracts showed higher activity against cancer cells based on IC\textsubscript{50} as compared to HCEC normal cells (Table 4). The best inhibitory concentration of ethanolic extract against MCF-7 was 47.3 µg/mL, much lower than that against HCEC cells (406 µg/mL), providing an evident clue that R. dentatus is more toxic against cancer cells as compared to normal cells (Table 4). Such higher cytotoxic effects against cancer cells and lower effects towards normal cells suggested that studied plant has excellent anti-cancer constituents.

In conclusion, the present study concluded that R. dentatus can be of interest for the treatment of MDR bacterial and pathogenic fungal infections. The ethanolic extract of R. dentatus showed significant cytotoxic activity against MCF-7 cell line and can be regarded as a possible remedy for breast cancers. Undertaken research paves a worthwhile foundation for the groups working on bioactivity guided isolation of natural products to search for a suitable, non-toxic drug to treat breast cancers.

**ACKNOWLEDGEMENTS**

The authors are grateful to the Dr Muhammad Ismail at Institute of biomedical and genetic engineering Islamabad, Pakistan for his help in order to investigate the antibacterial and antifungal activity.

**REFERENCES**

1. Fatima N, Rizwan M, Hobani YH, Marwan SAE, Kumar BV. Gas chromatography/Mass spectroscopy analysis of Catha edulis Forsk, a psycho stimulant revealed potent sol-


12 Demirezer LÖ. Comparison of two Rumex species with spectrophotometric method and chromatographic identification with regard to anthaquinone derivatives. Planta Medica 1993; 59(S1): A630.


20 Prieto P, Pineda M, Aguilar M. Spectrophotometric quantitation of antioxidant capacity through the formation of a phosphomolybdenum complex: specific application to the determination of vitamin E. Anal Biochem 1999; 269(2): 337-341.


---

Table 4: Cytotoxicity of R. dentatus extracts against different cell lines (µg/mL)

<table>
<thead>
<tr>
<th>Sample</th>
<th>MCF-7</th>
<th>DU-145</th>
<th>Hep-2 IC50</th>
<th>HCEC IC50</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM</td>
<td>53.0±3.6</td>
<td>134.0±3.6</td>
<td>123.0±2.6</td>
<td>394.0±1.5</td>
</tr>
<tr>
<td>RE</td>
<td>47.3±1.8</td>
<td>139.0±2.3</td>
<td>128.0±2.4</td>
<td>406.0±1.3</td>
</tr>
<tr>
<td>RB</td>
<td>49.0±2.5</td>
<td>94.0±3.4</td>
<td>146.0±3.8</td>
<td>367.0±2.3</td>
</tr>
<tr>
<td>RC</td>
<td>48.0±3.9</td>
<td>99.0±4.6</td>
<td>134.0±2.4</td>
<td>383.0±2.8</td>
</tr>
<tr>
<td>RH</td>
<td>89.3±2.3</td>
<td>213.0±3.8</td>
<td>194.0±2.1</td>
<td>491.0±2.9</td>
</tr>
</tbody>
</table>

Notes: RM: Rumex dentatus (R. dentatus) methanol; RE: R. dentatus ethanol; RB: R. dentatus benzene; RC: R. dentatus chloroform and RH: R. dentatus n-hexane. Data was articulated as mean (IC50) ± standard error of mean (n = 3) of three independent experiment.


