

ID Design Press, Skopje, Republic of Macedonia
 Open Access Macedonian Journal of Medical Sciences. 2019 Apr 15; 7(7):1071-1076.
<https://doi.org/10.3889/oamjms.2019.209>
 eISSN: 1857-9655
Basic Science



In Vivo Toxicity Study of Ethanolic Extracts of *Evolvulus alsinoides* & *Centella asiatica* in Swiss Albino Mice

Mukesh Kumar Yadav^{1*}, Santosh Kumar Singh², Manish Singh³, Shashank Shekhar Mishra⁴, Anurag Kumar Singh², Jyoti Shankar Tripathi¹, Yamini Bhusan Tripathi⁵

¹Department of Kayachikitsa, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India; ²Centre of Experimental Medicine & Surgery, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India; ³Department of Pharmacology, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India; ⁴Department of Vikriti Vigyan, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India; ⁵Department of Medicinal Chemistry, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India

Abstract

Citation: Yadav MK, Singh SK, Singh M, Mishra SS, Singh AK, Tripathi JS, Tripathi YB. In Vivo Toxicity Study of Ethanolic Extracts of *Evolvulus alsinoides* & *Centella asiatica* in Swiss Albino Mice. Open Access Maced J Med Sci. 2019 Apr 15; 7(7):1071-1076. <https://doi.org/10.3889/oamjms.2019.209>

Keywords: Centella asiatica; Evolvulus alsinoides L.; Ethanolic extracts; Sub-acute; Toxicity

***Correspondence:** Prof. Jyoti Shankar Tripathi and Mukesh Kumar Yadav. Department of Kayachikitsa, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India. E-mail: mukesh.yadav@bhu.ac.in

Received: 09-Jan-2019; **Revised:** 04-Mar-2019; **Accepted:** 05-Mar-2019; **Online first:** 11-Apr-2019

Copyright: © 2019 Mukesh Kumar Yadav, Santosh Kumar Singh, Manish Singh, Shashank Shekhar Mishra, Anurag Kumar Singh, Jyoti Shankar Tripathi, Yamini Bhusan Tripathi. This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0)

Funding: This research did not receive any financial support

Competing Interests: The authors have declared that no competing interests exist

AIM: We aimed to investigate several parameters after the *in vivo* acute and sub-acute administration of ethanolic extracts from *E. alsinoides* & *C. asiatica*.

METHODS: Malignant Ovarian Germ Cell Tumors for *in vivo* toxicity study guidelines 423 and 407 of Organization for Economic Co-operation and Development (OECD) were followed for acute and sub-acute toxicity assays respectively. For LD50 evaluation, a single dose of ethanolic extracts of *Evolvulus alsinoides* L. (EEA) and ethanolic extracts of *Centella asiatica* (ECA) was orally administered to mice at doses of 200, 400, 800, 1600 and 2000 mg/kg. Then the animals were observed for 72 hours. For acute toxicity evaluation, a single dose of both extracts was orally administered to mice at doses of 300, 600, 1200 and 2000 mg/kg and the animals were observed for 14 days. In the sub-acute study, the extracts were orally administered to mice for 28 days at doses of 300, 600, 1200 and 2000 mg/kg. To assess the toxicological effects, animals were closely observed on general behaviour, clinical signs of toxicity, body weight, food and water intake. At the end of the study, it was performed biochemical and hematological evaluations, as well as histopathological analysis from the following organs: brain, heart, liver, and kidney.

RESULTS: The oral administration of *E. alsinoides* and *C. asiatica* ethanolic extracts, i.e. EEA 300, EEA 600, EEA 1200, EEA 2000, ECA 300, ECA 600, ECA 1200 & ECA 2000 mg/kg doses showed no moral toxicity effect in LD50, acute and sub-acute toxicity parameters.

CONCLUSION: In this study, we had found that *E. alsinoides* & *C. asiatica* extract at different doses cause no mortality in acute and sub-acute toxicity study. Also, histopathology of kidney, liver, heart, and brain showed no alterations in tissues morphology.

Introduction

Centella asiatica belonging to the family: Apiaceae is native to most of the Asian countries. Being herbaceous, it contains stems which are long, filiform and prostrate with long internodes containing roots, 1-5 leaves per node which are 50-350 cm in radius, uninformed, deeply cordate, long-petioled and oval or orbicular in shape, 3-6 small flowers which are purple to white-green in color and are arranged in umbels arising from the axis of the leaves. *Centella asiatica* grows well in both tropical and sub-tropical

countries. The pharmacological activity of *Centella asiatica* is due to several active constituents including kaempferol-3-o- β -d-glucuronide, quercetin-3-o- β -d-glucuronide, castillicetin, apigenin, rutin, luteolin, naringin [1], [2] rosmarinic acid, chlorogenic acid, 3,4-di-o-caffeoyl quinic acid, 1,5-di-o-caffeoyl quinic acid, 3,5-di-o-caffeoyl quinic acid, 4,5-di-o-caffeoyl quinic acid, isochlorogenic acid, asiaticoside, centelloside, madecassoside, brahmoside, brahminoside (saponin glycosides), asiaticentoic acid, centellic acid, madecassic acid, terminolic acid and betulic acid [3].

The plant *Centella asiatica* has been reported

as traditionally used for various ailments including wound healing, bronchitis, asthma, diabetes, allergy, cancer, diuretic, and hypertension and to improve mental ability [4], [5], [6], [7].

Evolvulus alsinoides L. (Family: *Convolvulaceae*) is a small genus composed of about 10–15 species widely distributed in Asian and American countries, with some of its species used medicinally. *Evolvulus alsinoides* is one of the several well-known Ayurvedic crude drugs that have a significant place in the traditional medicinal system of India due to its memory enhancing properties. In *Evolvulus alsinoides* some active chemical constituents present like triacontane, pentatriacontane, evolving, β -sitosterol, two alkaloids betaine and shankpushpin, caffeic acid, 6-methoxy-7-O-b-glucopyranoside coumarin, kaempferol-7-O-b-glucopyranoside, kaempferol-3-O-b-glucopyranoside and kaempferol-3-O-b-glucopyranoside and quercetine- 3-O-b-glucopyranoside in this species [8].

This plant has some traditional pharmacological activities such as gastro protective [9], antibacterial [10], antiulcer [11], immunomodulatory [12], cytoprotective [13], adaptogenic and anti-amnesic [14], anxiolytic [15], diabetes [16], syphilis [17], tonic to brain strength & memory enhancer [18], analgesic and anti-inflammatory activity [19].

We aimed to investigate several parameters after the *in vivo* acute and sub-acute administration of ethanolic extracts from *E. alsinoides* & *C. asiatica*.

Material and Methods

Plant material

Whole plant material of *Centella asiatica* and *Evolvulus alsinoides* were collected from village Ramnapur, Varanasi, Uttar Pradesh, India in October 2015 and authentication was done by Department of Botany, Banaras Hindu University, India and also herbarium of *Evolvulus alsinoides* (voucher specimen no. Convolvul./03/2015) and *Centella asiatica* (voucher specimen no. Apia/02/2015) plants were deposited in the Department of Botany, Banaras Hindu University, India.

Preparation of extracts

The extraction of both plants was done with Soxhlet method in ethanolic solvents at 72–82°C for 72 hours. The Soxhlet extraction has widely been used for extracting valuable bioactive compounds from various natural sources. It is used as a model for the

comparison of new extraction alternatives. Generally, a small amount of dry sample is placed in a thimble. The thimble is then placed in distillation flask which contains the solvent of particular interest. After reaching an overflow level, the solution of the thimble-holder is aspirated by a syphon.

Syphon unloads the solution back into the distillation flask. This solution carries extracted solutes into the bulk liquid. The solute has remained in the distillation flask, and solvent passes back to the solid bed of plant. The process repeatedly runs until the extraction is completed. Per cent yield for *Centella Asiatica* and *Evolvulus alsinoides* were 16.7% w/w and 15.3% w/w respectively.

Preparation of extract samples

Ethanolic extracts of *E. alsinoides* (EEA) and *C. asiatica* (ECA) were solubilized in distilled water to obtain solutions of 30, 60, 120 and 200 mg/ml. The doses were evaluated as 300, 600, 1200 and 2000 mg/kg.

Toxicity assays

The safety parameters assessed by conducting the acute and sub-acute toxicity study according to the OECD guidelines [20] 423 and 407 respectively.

Animals

The experimental Swiss albino mice (male and female) 7-8-week-old of 25-30 gm weight were issued by Animal house of Institute of Medical Sciences, Banaras Hindu University Varanasi, Uttar Pradesh. Animals were divided into experimental groups, housed in plastic cages and maintained on a 12-hour light and 12-hour dark cycle. They were given standard food and water ad libitum. The Central Animal Ethical Committee of Banaras Hindu University approved all experimental procedures (CAEC/196).

LD 50 assay

LD50 (Lethal Dose) is the amount of a drug or extracts given at once, which causes the death of 50% population of test animals. This is one way to measure the short-term toxicity of the drug or extract. For LD50 a single dose of ethanolic extracts of both plants *Centella asiatica* and *Evolvulus alsinoides* L. was orally administered to mice at doses of 200, 400, 800, 1600 and 2000 mg/kg. Then the animals were observed for 72 hours.

Acute toxicity assay

The animals were divided into nine experimental groups of 6 animals each (3 male and 3 female). Group 1 received 10 µl/g of distilled water and served as control.

Groups 2 to 5 treated with ethanolic extract of *E. alsinoides* (EEA) at the doses of 300, 600, 1200 and 2000 mg/kg.

Groups 6 to 9 were treated with ethanolic extract of *C. asiatica* (ECA) at doses of 300, 600, 1200 and 2000 mg/kg respectively.

All treatments were administered once by oral gavage. Animals were closely observed for 4 hours following administration and once a day for 14 days on general behaviour, clinical signs of toxicity, mortality, food and water intake. Body weight was measured before and after administration on days 4, 7, 10 and 14. At the end of the experiment, animals were anaesthetized with ketamine (20 mg/kg i.p.). After the anaesthesia has reached depth, the cardiac puncture was performed to collect blood for biochemical and haematological evaluations.

Sub-acute toxicity assay

The animals were divided into nine experimental groups of 6 animals each (3 male and 3 female). Group 1 received 10 µl/g of distilled water and served as control.

Groups 2 to 5 treated with ethanolic extract of *E. alsinoides* (EEA) at the doses of 300, 600, 1200 and 2000 mg/kg.

Groups 6 to 9 were treated with ethanolic extract of *C. asiatica* (ECA) at doses of 300, 600, 1200 and 2000 mg/kg respectively.

All treatments were administered once by oral gavage daily 7 days each week for 28 days. Animals were closely observed for 28 days on general behaviour, clinical signs of toxicity, mortality, food and water intake. Body weight was measured before and after administration on days 7, 14, 21 and 28. At the end of the experiment, animals were anaesthetised with ketamine (20 mg/kg i.p.). After the anaesthesia has reached depth, the cardiac puncture was performed to collect blood for biochemical and haematological evaluations.

Haematological analysis

The haematological evaluation was performed in all surviving animals at the end of the experiment. The complete blood count was performed using an automated haematology analyser. Haematological evaluations included haemoglobin concentration (HGB), red blood cell count (RBC), platelet count (PLT), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean

corpuscular haemoglobin concentration (MCHC) and white blood cell count (WBC).

Blood serum biochemistry analysis

The biochemical evaluation was performed in all surviving animals at the end of the experiment. The collected blood was transferred to tubes without anticoagulant and allowed to stand for 60 min at room temperature and centrifuged at 4000 rpm for 10 min. The serum from each blood sample was recovered and stored in cryogenic tubes at -80°C deep freezer. Urea, Creatinine, Serum glutamic oxaloacetic transaminase (SGOT), Serum glutamic pyruvic transaminase (SGPT) and alkaline phosphatase were evaluated.

Histopathology

The organs were collected from all surviving animals, washed with saline solution 0.9% (w/v), weight and fixed in 40% formaldehyde solution. Then organs were processed for paraffin embedding. Five µm thick sections were prepared and stained with hematoxylin and eosin (H&E). The tissues were analysed in an optical microscope for their general structure, signs of inflammation, degenerative changes and necrosis evidence. The images were captured with the microscope Motic B1 series, scanned through micro camera Moticam 480 using the Motic Images Plus 2.0ML Application Suite software.

Statistical analysis

The relative haematological and biochemical data were expressed as mean ± standard error of the mean (SEM). Data were submitted to analysis of variance (one-way ANOVA) followed by Dunnett's multiple comparison tests. The results were expressed as mean ± SEM. The software GraphPad Prism 6.0 (GraphPad Software, USA) was used for statistical analysis. P < 0.05 were considered statistically significant.

Results

Acute toxicity & Sub-acute toxicity

General signs and mortality

No deaths were recorded within 72 hours in LD50 assay after administration of the extracts. No signs of toxicity were observed in animal groups after the treatment with EEA 300, EEA 600, EEA 1200, EEA 2000, ECA 300, ECA 600, ECA 1200 and ECA 2000 mg/kg.

Body weight, relative organ weight, food and water intake

Animal treated with EEA and ECA at the three evaluated doses showed weight gain throughout the entire experiment duration. The increase was the same in treated and control group animals, and the treatment did not affect relative organs weights, food, and water intake (Table 1).

Table: 1 List of different parameters and general signs assessed during toxicity study

Parameters	Dose (mg/kg)							
	EEA 300	EEA 600	EEA 1200	EEA 2000	ECA 300	ECA 600	ECA 1200	ECA 2000
Body weight	N	N	N	N	N	N	N	N
Feed Intake	N	N	N	N	N	N	N	N
Water Intake	N	N	N	N	N	N	N	N
Fur Condition	N	N	N	N	N	N	N	N
Nails Colour	N	N	N	N	N	N	N	N
Eye Colour	N	N	N	N	N	N	N	N
Convulsion	N	N	N	N	N	N	N	N
Locomotion	N	N	N	N	N	N	N	N
Dyspnoea	N	N	N	N	N	N	N	N
Sedation	N	N	N	N	N	N	N	N
Aggressive Behavior	N	N	N	N	N	N	N	N

(Normal = N, Abnormal = Ab).

Table: 2 Hematological parameters of Swiss mice treated for 28 days with different doses (300, 600, 1200 and 2000 mg/kg) of ethanolic extracts of *E. alsinoides* (EEA) and *C. asiatica* (ECA) n = 6 swiss albino mice.

Groups	Haematological parameters							
	HGB (g/dL)	RBC ($10^6/\mu\text{L}$)	PLT ($10^3/\mu\text{L}$)	HCT (%)	MCV (fL)	MCH (pg)	MCHC (g/dL)	WBC ($10^3/\mu\text{L}$)
Control	12.3 ± 0.28	6.30 ± 0.30	901.2 ± 17.2	41.2 ± 1.09	57.0 ± 0.99	19.5 ± 0.50	32.1 ± 1.01	5.94 ± 0.20
EEA 300	13.0 ± 0.46	6.90 ± 0.17	771.3 ± 39.8	39.6 ± 1.07	54.0 ± 0.36	17.2 ± 0.72	31.3 ± 1.65	5.85 ± 0.55
EEA 600	12.7 ± 0.28	6.24 ± 0.24	936.4 ± 41.0	41.7 ± 1.06	57.4 ± 1.56	20.4 ± 1.06	33.7 ± 1.61	5.89 ± 0.42
EEA 1200	12.93 ± 0.73	6.46 ± 0.44	928.8 ± 23.8	43.66 ± 1.45	57.1 ± 0.96	19.26 ± 0.76	32.56 ± 0.63	5.48 ± 0.63
EEA 2000	13.33 ± 0.63	7.06 ± 0.69	795.9 ± 26.1	43.16 ± 2.00	57.20 ± 1.83	20.33 ± 1.80	31.86 ± 1.68	5.51 ± 0.39
ECA 300	13.63 ± 0.52	7.22 ± 0.31	816.1 ± 10.2	41.52 ± 1.29	55.09 ± 1.09	18.75 ± 1.10	30.77 ± 1.21	5.46 ± 0.29
ECA 600	12.6 ± 0.3	6.66 ± 0.24	795.7 ± 9.1	39.2 ± 0.46	53.43 ± 0.66	16.86 ± 0.17	28.36 ± 1.53	4.89 ± 0.16
ECA 1200	13.5 ± 0.4	7.25 ± 0.5	862.5 ± 14.7	45.5 ± 1.9	55.8 ± 0.8	18.8 ± 0.7	32.9 ± 0.7	5.27 ± 0.5
ECA 2000	13.6 ± 0.57	7.46 ± 0.78	784.3 ± 25.5	46.2 ± 1.12	57.5 ± 1.47	20.8 ± 1.28	33.5 ± 0.40	5.79 ± 0.21

One-way ANOVA followed by Dunett's multiple comparison tests. *p < 0.05, **p < 0.01, ***p < 0.001. Abbreviations: Hemoglobin concentration (HGB), Red blood cell count (RBC), platelet count (PLT), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and white blood cell count (WBC).

Haematological parameters

Treatment with EEA and ECA at all doses did not produce any changes on animal haematological parameters.

Biochemical parameter

Treatment with EEA and ECA at all doses did not produce any statistically significant changes on Urea, Creatinine, SGOT, SGPT and alkaline phosphatase (Table 3).

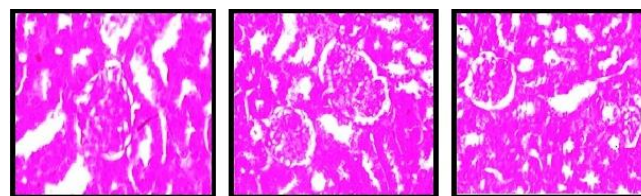
Table 3: Blood serum biochemical parameters of Swiss albino mice treated with dosage (300, 600, 1200 & 2000 mg/kg) of ethanolic extracts of *E. alsinoides* & *C. asiatica*. N = 6 swiss albino mice.

Groups	Urea	Creatinine	SGOT	SGPT	Alkaline phosphatase
	Normal value = 25-30 mg/dl	Normal value = 0.2-0.9 mg/dl	Normal value = 54-298 mg/dl	Normal value = 17-77 mg/dl	Normal value = 35-96 mg/dl
Normal	26.80 ± 1.12	0.3 ± 0.06	57.92 ± 1.62	58.18 ± 3.22	39.41 ± 3.22
EEA 300	26.54 ± 0.82	0.4 ± 0.08	58.59 ± 4.19	52.69 ± 1.11	55.45 ± 4.76
EEA 600	27.45 ± 0.62	0.6 ± 0.1	55.19 ± 2.06	62.67 ± 6.26	46.51 ± 5.73
EEA 1200	27.68 ± 0.68	0.4 ± 0.08	55.26 ± 1.30	59.10 ± 2.8	48.87 ± 2.05
EEA 2000	27.88 ± 0.82	0.4 ± 0.12	61.82 ± 4.28	51.45 ± 8.93	54.38 ± 3.33
ECA 300	27.38 ± 1.02	0.5 ± 0.13	55.08 ± 0.57	63.82 ± 5.79	51.54 ± 4.08
ECA 600	26.33 ± 0.68	0.4 ± 0.12	56.24 ± 1.24	52.80 ± 1.77	55.55 ± 5.08
ECA 1200	27.36 ± 1.80	0.5 ± 0.05	58.24 ± 2.00	59.36 ± 3.56	41.32 ± 3.69
ECA 2000	26.24 ± 0.83	0.2 ± 0.03	57.94 ± 4.51	57.49 ± 2.53	50.82 ± 2.08

One-way ANOVA followed by Dunett's multiple comparison test. *p < 0.05, **p < 0.01, ***p < 0.001.

Histopathological analysis

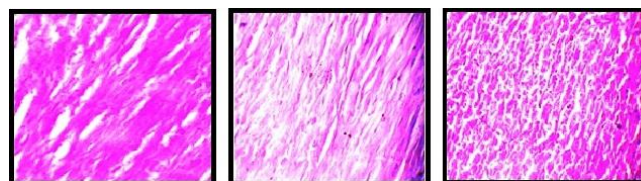
The oral administration of ECA and EEA did not produce significant dose-dependent Histopathological alterations. At the four evaluated doses, it was not observed any tissue damage on the kidney, heart, liver and brain of mice.



(a) Normal (b) EEA (c) ECA

Figure 1: Histopathological slides of kidney organ shown no changes in Swiss albino mice treated with (b) EEA & (c) ECA extracts

Microscopic histological slides from different organs of Swiss albino mice treated with ethanolic extracts of *E. alsinoides* & *C. asiatica*, i.e. EEA & ECA respectively are shown in Figures 1 to 4.



(a) Normal (b) EEA (c) ECA

Figure 2: Histopathological slides of heart organ shown no changes in Swiss albino mice treated with (b) EEA & (c) ECA extracts

Discussion

To assess preliminary toxicity study animal models are widely used because the early

identification of side effects is usually predictive of the toxicity in humans and can save time, resources and efforts [21]. In this study, several parameters evaluated after the *in vivo* acute and sub-acute administration of ethanolic extracts from *E. alsinooides* & *C. asiatica* were investigated. In toxicological evaluation mortality is an important criterion [22] and there was no mortality seen in both acute and sub-acute evaluation of extracts. For LD50 no death was recorded in 72 hours of administration of extracts.

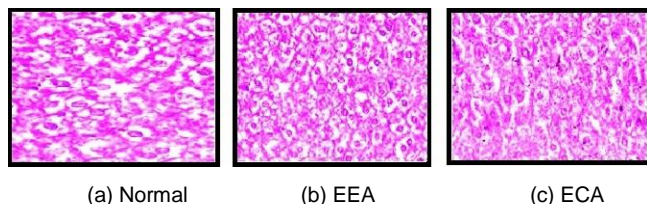


Figure 3: Histopathological slides of LIVER organ shown no changes in Swiss albino mice treated with (b) EEA & (c) ECA extracts

In acute toxicity, no death was recorded in 14 days extracts administration and in sub-acute toxicity study also no death recorded for 28 days extract administration. Clinical signs of toxicity were observed after the acute administration and during the sub-acute evaluation for all extract dosage. Liver damage is usually assessed by the determination of SGOT, SGPT, and alkaline phosphatase.

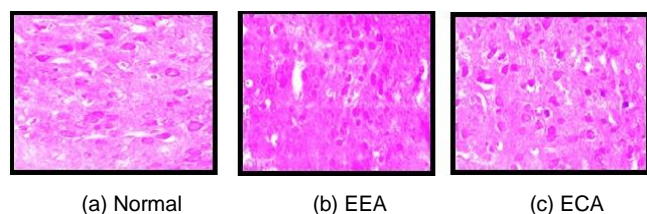


Figure 4: Histopathological slides of brain organ shown no changes in Swiss albino mice treated with (b) EEA & (c) ECA extracts

It was not observed any significant alterations in serum levels of these three markers of liver function after acute and sub-acute administration of extracts and histopathological analysis did not show liver damage. Renal function was evaluated by serum levels of urea, creatinine and by histological analysis.

The histopathological evaluation did not reveal alterations in this organ of any treated groups of sub-acute toxicity. Also, no tissue alterations found in the heart and brain of animals treated with 28 days *E. alsinooides* & *C. asiatica* extracts.

In this study, we had found that *E. alsinooides* & *C. asiatica* extracts at different doses cause no mortality in acute and sub-acute toxicity study. In addition, histopathology of kidney, liver, heart, and brain showed no alterations in tissues morphology.

Acknowledgement

The authors would like to thank the staff of Centre of Experimental Medicine & Surgery (CEMS), Institute of medical sciences, Banaras Hindu University, Varanasi for providing the well-equipped laboratory & animal house to conduct this study.

References

- Bhandari P, Kumar N, Gupta AP, Singh B, Kaul VK. A rapid RP-HPTLC densitometry method for simultaneous determination of major flavonoids in important medicinal plants. *Journal of separation science*. 2007; 30(13):2092-6. <https://doi.org/10.1002/jssc.200700066> PMID:17654615
- Zheng C, Qin L. Chemical components of *Centella asiatica* and their bioactivities. *Journal of Chinese Integrative Medicine*. 2007; 5(3):348-51. <https://doi.org/10.3736/jcim20070324> PMID:17498500
- Barnes J, Anderson LA, Phillipson JD. *Herbal medicines*. Pharmaceutical Press, 2007.
- Kumar MV, Gupta YK. Effect of different extracts of *Centella asiatica* on cognition and markers of oxidative stress in rats. *Journal of ethnopharmacology*. 2002; 79(2):253-60. [https://doi.org/10.1016/S0378-8741\(01\)00394-4](https://doi.org/10.1016/S0378-8741(01)00394-4)
- Pittella F, Dutra R, Junior D, Lopes MT, Barbosa N. Antioxidant and cytotoxic activities of *Centella asiatica* (L) Urb. *International journal of molecular sciences*. 2009;10(9):3713-21. <https://doi.org/10.3390/ijms10093713> PMID:19865514 PMID:PMC2769141
- Park BC, Bosire KO, Lee ES, Lee YS, Kim JA. Asiatic acid induces apoptosis in SK-MEL-2 human melanoma cells. *Cancer letters*. 2005; 218(1):81-90. <https://doi.org/10.1016/j.canlet.2004.06.039> PMID:15639343
- Tang B, Zhu B, Liang Y, Bi L, Hu Z, Chen B, Zhang K, Zhu J. Asiaticoside suppresses collagen expression and TGF- β /Smad signaling through inducing Smad7 and inhibiting TGF- β RI and TGF- β RII in keloid fibroblasts. *Archives of dermatological research*. 2011; 303(8):563-72. <https://doi.org/10.1007/s00403-010-1114-8> PMID:21240513
- Gupta P, Siripurapu KB, Ahmad A, Palit G, Arora A, Maurya R. Anti-stress Constituents of *Evolvulus alsinooides*: An Ayurvedic Crude Drug. *Chem Pharma Bull*. 2007; 55:771. <https://doi.org/10.1248/cpb.55.771>
- Ratnasooriya WD, Hewageegana HGSP, Jayakody JRAC, Ariyawansa HAS, Kulatunga RDH. Gastroprotective activity of *Evolvulus alsinooides* L. powder. *Aust J Med Herbalism*. 2005; 17:55-60.
- Tharan NT, Vadivu R, Palanisamy M, Justin V. Antibacterial Activity of *Evolvulus alsinooides*. *Indian Drugs*. 2003; 40:585-586.
- Purohit MG, Shanthaveerappa BK, Badami S, Swamy HKS, Shrishailappa B. Antiulcer and antiscatonic activity of alcoholic extract of *Evolvulus alsinooides* (Convolvulaceae). *Ind J Pharma Sci*. 1996; 58:110-112.
- Ganju L, Karan D, Chanda S, Srivastava KK, Sawhney RC, Selvamurthy W. Immunomodulatory effects of agents of plant origin. *Biomed-Pharmacother*. 2003; 57:296-300. [https://doi.org/10.1016/S0753-3322\(03\)00095-7](https://doi.org/10.1016/S0753-3322(03)00095-7)
- Bhatnagar M, Shukla SD, Jain S, Mundra A. Cytoprotective effects of Shankhpushpi - an *E. alsinooides* preparation on Hippocampal cells in mice. *Indian Drugs*. 2000; 37:280-285.
- Siripurapu KB, Gupta P, Bhatia G, Maurya R, Nath C, Palit G. Adaptogenic and anti-amnesic properties of *Evolvulus alsinooides* in

- rodents. *Pharmacol Biochem Behav.* 2005; 81:424-432.
<https://doi.org/10.1016/j.pbb.2005.03.003> PMID:15899513
15. Alok Nahata, U.K. Patil, and V.K. Dixit. Anxiolytic activity of *Evolvulus alsinoides* and *Convolvulus pluricaulis* in rodents. *Pharmaceutical Biology.* 2009; 47(5):444-451.
<https://doi.org/10.1080/13880200902822596>
16. Alam MM, Siddiqui MB, Hussain W. Treatment of diabetes through herbal drugs in rural India. *Fitoterapia.* 1990; 61:240-242.
17. Goyal PR et al. Shankhpushpi (*Evolvulus alsinoides* Linn): a medicinal herb. *Int J Mendel.* 2005; 22:124.
18. Auddy B, Ferreira M, Blasina F et al. Screening of Antioxidant activity of some three Indian medicinal plants traditionally used for the management of neurodegenerative diseases. *Journal of Ethnopharmacology.* 2003; 84:131-138.
[https://doi.org/10.1016/S0378-8741\(02\)00322-7](https://doi.org/10.1016/S0378-8741(02)00322-7)
19. Kankariya RD, Shetty SC, Shete RV, Ingale SD. *Deccan J Pharmacology.* 2011; 2(4).
20. Organization for Economic Co-operation and Development guideline 407 & 423.
21. Kramer JA, O'Neill E, Phillips ME, Bruce D, Smith T, Albright MM, Bellum S, Gopinatan S, Heydorn WE, Liu X, Nouraldeen A, Payne BJ, Read R, Vogel P, Yu XQ, Wilson AGE. Early toxicology signal generation in the mouse. *Toxicol. Pathol.* 2010; 38:452-471.
<https://doi.org/10.1177/0192623310364025> PMID:20305093
22. Asare GA, Gyan B, Bugyei K, Adjei S, Mahama R, Addo P, Otu-Nyarko L, Wiredu EK, Nyarko A. Toxicity potentials of the nutraceutical *Moringa oleifera* at supra-supplementation levels. *Journal of ethnopharmacology.* 2012; 139(1):265-72.
<https://doi.org/10.1016/j.jep.2011.11.009> PMID:22101359