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RESEARCH ARTICLE

HYPOGLYCEMIC AND HYPOLIPIDEMIC POTENTIAL OF *CENTELLA ASIATICA* ETHANOLIC EXTRACT ON CADMIUM INTOXICATED ALBINO RATS

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ABSTRACT

Present study was designed to examine the hypoglycemic and hypolipidemic effect of *Centella asiatica* ethanolic leaves extract on cadmium chloride treated albino rats. Administration of cadmium chloride (5 mg/kg body weight) in rats caused an increase in the glucose, cholesterol, LDL, VLDL, triglycerides, phospholipids and free fatty acids. A decrease in the HDL was also found in cadmium chloride treated group. Various concentrations of *Centella asiatica* ethanolic extract or silymarin (50 mg/kg body weight) as a pre-treatment were administered for 30 days to rats treated with cadmium chloride. The levels of all the above parameters were restored to near normal levels in rats. The effectiveness of the treatment was concentration dependent and effective concentration of ethanolic leaves extract was found to be 80 mg/kg bw. At this concentration, the extract's protective effect was comparatively similar to silymarin and can help restore disparities in cadmium treated rats to near normal levels.

INTRODUCTION

Cadmium (Cd) is a toxic pollutant. Major occupational as well as environmental pollution from Cd are due to anthropogenic activities such as mining, metallurgical industries, electro platting, manufacturing of Nickel–Cadmium batteries, pigments, plastic stabilizers, etc. (Friberg, *et al*., 1986; Bertin and Averbeck, 2006). International Agency for Research on Cancer (IARC, 1993) has classified Cd as a carcinogen. Cd accumulates predominantly in the liver and kidney, with a long biological half-life of approximately 17 to 30 years in humans (Hideaki *et al*., 2008). Prolonged Cd exposure can also aggravate cancer. In non-smoking population, cadmium exposure is generally through food due to the use of phosphate fertilizers and water as well as air contaminations. In smoking population, Cd enters the body through the fumes of cigarette (Hassan *et al*., 2005). Tobacco plant is known for absorbing high levels of cadmium (IPCSs, 1992, 2010).

Centella asiatica L. (Apiaceae) which is commonly known as Asiatic pennywort or Indian pennywort, belongs to the family Apiaceae (formerly known as Umbelliferae). It is a slender, prostrate, glabrous, perennial creeping herb rooting at the nodes, with simple petiolate, palmately lobed leaves. It is extensively cultivated in Southeast Asia, India, China, Sri Lanka, etc., as vegetable or spice. *Centella asiatica* L. (Apiaceae) has various pharmacological activities like memory enhancing, anti-inflammatory, antioxidant, wound healing, immune-stimulant, anti-anxiety (anti-hypertensive), anti-stress and anti-epilepsy. Various health benefits of *Centella asiatica* L. (Apiaceae) has lead to the amplified usage of this plant in food and beverages. It has been extensively used for treatment of ailments like inflammation, syphilis, mental illness, skin diseases, rheumatism, inflammation, syphilis, mental illness, epilepsy, hysteria, diarrhea, wounds, dehydration, and ulcers (Yu *et al*., 2006; Mukherjee *et al*., 2011; Meena *et al*., 2012; Seevaratnam *et al*., 2012) The present study tries to understand some of the changes in the body weight, fasting blood glucose levels, lipid profile, phospholipids and free fatty acids in cadmium chloride treated albino rats and its probable mitigation by *Centella asiatica* L. (Apiaceae) ethanolic leaves extract.

MATERIALS AND METHODS

Chemicals

Cadmium chloride was obtained from SRL (Sisco Research Laboiratories Pvt. Ltd, Mumbai, India. All reagents used for

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the biochemical estimations in this study were procured from Sigma Chemical Co. Ltd, USA and Himedia Laboratories Pvt Ltd, Mumbai, India.

Plant Material collection and identification

Centella asiatica L. (Apiaceae) used in this study was collected from Thanjavur district, Tamil Nadu, India. The plant was identified at the herbarium of Department of Botany, Annamalai University. A voucher specimen (Herbarium No. DDE/HER/53) was deposited in the Department Herbarium for future reference. The leaves were washed under running tap water to remove dirt and other debris. It was then spread under a clean shade for drying. The dried leaves were milled to coarse powder using a mechanical grinder and stored in an air-tight container until further use.

Ethanolic extraction of plant material

Approximately 500g kg of powered *Centella asiatica* L. (Apiaceae) leaves were used for ethanolic extraction using Soxhlet apparatus. The dark green extract obtained was subjected to ultracentrifugation followed by micro-filtration. The final clear dark extract was then concentrated in a rotary evaporator under reduced pressure. The final dried extract was lyophilized and was stored in a glass vials at -20°C for further use. This extract was then subjected to preliminary qualitative analysis.

Percentage yield of plant extract

The percentage yield of the extract was determined gravimetrically using the dry weight of the crude extract obtained (X) and dry weight of plant leaves powder used for the extraction (Y) by using the following formula:
Percentage yield = X/Y * 100

Qualitative screening

Phytochemical screening was carried out by using 1 gram of the dried ethanolic extract which was subjected to phytochemical test as described below (Harborne, 1973; Trease and Evans, 1983, 2002).

***Detection of alkaloids* (Mayer's Test)**

The extract was dissolved in dilute Hydrochloric acid and filtered. The filtrate was treated with Mayer's reagent (potassium mercuric iodide). Formation of whitish yellow or creamy coloured precipitate indicates the presence of alkaloids.

***Detection of phenols* (Ferric Chloride Test)**

Diluted extract was treated with 3-4 drops of neutral 5% ferric chloride solution. Formation of dark green colour indicates the presence of phenols.

***Detection of flavonoids* (Alkaline Reagent Test)**

Extract was treated with few drops of sodium hydroxide solution. Formation of intense yellow colour, which becomes colourless on addition of diluted acid, indicates the presence of flavonoids.

Detection of quinones

The extract was treated with few drops of sulphuric acid. Formation of red colour indicates the presence of quinones.

Detection of tannins (Gelatin Test)

To the extract 1% gelatin solution containing 10% sodium chloride was added. Formation of white precipitate indicates the presence of tannins.

Detection of saponins (Foam Test)

0.5 gm of extract was shaken with 2 ml of water. If the foam produced persisted for ten minutes, it indicates the presence of saponins.

Detection of terpenoids (Salkowski test)

The extract was added to 2 ml of chloroform. Concentrated H_2S0_4 (3 ml) was carefully added to form a layer. A reddish brown colouration at the interface indicates the presence of terpenoids.

***Detection of fixed oils and fats* (Saponification test)**

Detection of fixed oils and fats were carried out as described by Kokate, 1999. A few drops of 0.5 N alcohol potassium hydroxide solution is added to a small quantity of extract along with a drop of phenolphthalein solution. The mixture is heated on water bath for 1-2 hours. Formation of soap indicates the presence of fixed oils and fats in the extract.

Animals

Male Wistar albino rats of body weight 160–180 g were used for this study. The animals were bred and maintained at Central Animal House, Rajah Muthiah Medical College, Annamalai University, Annamalainagar, Chidambaram, India. Rats were fed on standard pellet diet ((Lipton India Ltd., Mumbai, India) and water *ad libitum*. The animals were housed in polycarbonate cages in a room with a 12 h day–night cycle. The protocol (Proposal No. 1022, 2013) of this study was approved by the Institutional Ethical Committee of Annamalai University.

Experimental Design

The rats were divided into nine groups each comprising of six rats.

Group 1: Normal control rats (saline and 0.5% DMSO) (*n* =6)
Group 2: Cadmium chloride treated rats (5 mg/kg body weight, intragastrically) (*n* =6)
Group 3: *Centella asiatica* ethanolic leaves extract (20 mg/kg body weight; pre-treatment before 1 hour) + Cadmium chloride (5 mg/kg body weight) (*n* =6)
Group 4: *Centella asiatica* ethanolic leaves extract (40 mg/kg body weight; pre-treatment before 1 hour) + Cadmium chloride (5 mg/kg body weight) (*n* =6)

Group 5: *Centella asiatica* ethanolic leaves extract (60 mg/kg body weight; pre-treatment before 1 hour) + Cadmium chloride (5 mg/kg body weight) (*n* =6)

Group 6: *Centella asiatica* ethanolic leaves extract (80 mg/kg body weight; pre-treatment before 1 hour) + Cadmium chloride (5 mg/kg body weight) (*n* =6)

Group 7: *Centella asiatica* ethanolic leaves extract (100 mg/kg body weight; pre-treatment before 1 hour) + Cadmium chloride (5 mg/kg body weight) (*n* =6)

Group 8: *Centella asiatica* ethanolic leaves extract treated rats (100 mg/kg body weight) (*n* =6)

Group 9: Silymarin (50 mg/kg body weight; pre-treatment before 1 hour) + Cadmium chloride (5 mg/kg body weight) (*n* =6)

All the treatments were administered orally using an intragastric tube daily for a period of 30 days. The experiment was terminated at the end of 30 days and the animals were fasted overnight, weighed and sacrificed by cervical decapitation. Blood samples were collected and centrifuged to separate serum.

Estimation of blood glucose

Fasting blood glucose was estimated by O-toluidine method (Sasaki *et al*., 1972)

Evaluation of lipid profile, phospholipids and free fatty acids in serum

The total cholesterol was determined by the method of Zlatkis *et al*. (1953). Triglycerides, HDL, LDL and VLDL were determined and calculated by adopting the method of Fossati and Lorenzo (1982), Gidez and Webb (1950) and Friedewald *et al*. (1972) respectively. Phospholipids and free fatty acids were determined by the method of Zilversmit and Davis (1950) and Falholt *et al*. (1973) respectively.

Statistical analysis

The data were expressed as mean ± SD (n = 3). Statistical analysis of the data was carried out by one-way analysis of variance (Anova) followed by Duncan's Multiple Range Test (DMRT) using a statistical package program (SPSS v11.5 for Windows) $p < 0.05$ were considered as statistically significant.

RESULTS

Percentage yield of plant extract

Table 1 shows the percentage yield of *Centella asiatica* (Ca) ethanolic extract and was found to be 2.418%.

Table 1 Percentage yield of plant extract

Plant	Solvent	Method	Weight of crude extract (g)	% yield
Centella asiatica	Ethanol	Soxhlet extraction	12.09	2.418

Qualitative screening of plant extract

The qualitative phytochemical screening of the extract showed the presence of alkaloids, phenols, flavanoids, quinones, triterpenoids and fixed oils and fats (Table 2).

Table 2 Qualitative analysis of *Centella asiatica* ethanolic extract.

Secondary metabolites	Test	*Centella asiatica*
Alkaloids	Mayer's Test	+
Phenols	Ferric Chloride Test	+
Flavanoids	Alkaline Reagent Test	+
Quinones	Sulphuric acid test	+
Tannins	Gelatin Test	-
Saponins	Foam Test	-
Terpenoids	Salkowski test	+
fixed oils and fats	Saponification test	+

+ Presence; - Absence

Body weight

Table 3 shows the body weight of control and experimental animals in each group. The mean body weight was significantly decreased ($p<0.05$) in cadmium chloride treated rats as compared to control rats. The body weight was found to be increased in cadmium chloride treated rats with 1 hour pre-treatment with the reference drug silymarin (50 mg/kg body weight) and *Centella asiatica* ethanolic leaves extract in a concentration dependent manner. Extract at a concentration of 80 mg/kg body weight was found to be most effective.

Table 3 Body weight of control and experimental animals in each group. Values are expressed as mean ±SD (n=6). Values not sharing a common superscript letter differ significantly at $p<0.05$ (DMRT).

Groups	Body weight (g)	
	Initial	Final
Group 1	178.00±10.24^{a}	218.00±4.73^{de}
Group 2	175.00±11.30^{a}	182.00±3.59^{a}
Group 3	181.00±8.64^{a}	190.10±9.56^{ab}
Group 4	180.00±10.16^{a}	196.00±11.20^{b}
Group 5	179.00±9.32^{a}	200.00±10.12^{bc}
Group 6	178.00±6.28^{a}	208.00±12.34^{cd}
Group 7	177.00±11.19^{a}	208.00±8.96^{cd}
Group 8	180.00±9.47^{a}	220.00±4.46^{e}
Group 9	177.00±5.67^{a}	209.00±11.22^{cd}

Estimation of blood glucose

Table 4 shows the levels of fasting blood glucose in animals of each group. The mean fasting blood glucose was significantly ($p<0.05$) increased in cadmium chloride treated rats as compared to control rats.

Table 4 Effect of *Centella asiatica* leaf ethanolic extract on fasting blood glucose in control and experimental animals. Values are expressed as mean ±SD (n=6). Values not sharing a common superscript letter differ significantly at $p<0.05$ (DMRT).

Groups	Fasting blood glucose (mg/dl)	
	Initial (7th day)	Final (30th day)
Group 1	85.51±2.57^{a}	85.43±2.81^{b}
Group 2	181.10±3.97^{f}	198.45±2.32^{f}
Group 3	191.21±5.77^{g}	189.91±3.09^{e}
Group 4	175.27±5.77^{e}	159.94±3.79^{d}
Group 5	134.96±2.04^{d}	121.89±1.36^{c}
Group 6	115.27±1.33^{c}	88.43±1.99^{b}
Group 7	115.27±1.37^{c}	88.43±2.09^{b}
Group 8	84.03±4.65^{a}	82.41±2.35^{a}
Group 9	110.11±2.37^{b}	87.82±1.34^{b}

The fasting blood glucose was found to be decreased in cadmium chloride treated rats with 1 hour oral pre-treatment with the reference drug silymarin (50 mg/kg body weight) and

Centella asiatica ethanolic leaves extract in a concentration dependent manner. Extract at a concentration of 80 mg/kg body weight was found to be most effective.

Table 5 Effect of *Centella asiatica* leaf ethanolic extract on lipid profile, phospholipids and free fatty acids in serum of control and experimental animals. Values are expressed as mean ±SD (n=6). Values not sharing a common superscript letter differ significantly at $p<0.05$ (DMRT).

Groups	Cholesterol mg/dl	Triglycerides mg/dl	HDL mg/dl	LDL mg/dl	VLDL mg/dl	Phospholipids mg/dl	Free fatty acids mg/dl
Group 1	75.31±4.80^{a}	56.79±2.67^{a}	13.12±0.23^{e}	50.83±4.04^{a}	11.36±0.53^{a}	110.21±10.32^{b}	80.51±7.91^{ab}
Group 2	172.41±2.47^{g}	174.14±2.36^{f}	6.98±0.45^{a}	130.61±1.54^{f}	34.83±0.47^{f}	191.10±11.09^{d}	188.08±3.77^{f}
Group 3	151.08±2.41^{f}	161.44±2.63^{e}	7.01±0.13^{a}	111.87±1.67^{e}	32.29±0.53^{e}	184.35±10.69^{d}	141.62±8.87^{e}
Group 4	128.15±3.90^{e}	123.08±2.66^{d}	9.42±0.53^{b}	94.12±2.84^{d}	24.62±0.53^{d}	146.68±8.09^{c}	122.03±3.57^{d}
Group 5	98.49±4.61^{d}	98.71±2.89^{c}	10.95±0.72^{c}	67.80±3.31^{c}	19.74±0.58^{c}	138.71±7.24^{c}	97.04±8.64^{c}
Group 6	85.35±2.22^{c}	67.31±3.44^{b}	12.11±0.34^{d}	59.80±1.23^{b}	13.46±0.69^{b}	121.45±11.19^{b}	86.51±7.27^{b}
Group 7	85.34±2.38^{c}	67.22±3.33^{b}	12.11±0.49^{d}	59.77±1.21^{b}	13.45±0.67^{b}	121.22±9.32^{b}	86.42±3.44^{b}
Group 8	73.42±3.46^{a}	54.42±2.67^{a}	13.40±0.12^{e}	49.14±2.80^{a}	10.88±0.53^{a}	90.03±9.32^{a}	77.15±7.12^{a}
Group 9	84.52±3.51^{c}	64.25±3.57^{b}	12.13±0.68^{d}	57.54±2.11^{b}	12.85±0.72^{b}	118.05±10.12^{b}	81.01±9.35^{ab}

Evaluation of lipid profile, phospholipids and free fatty acids in serum

The total cholesterol, LDL, VLDL, triglycerides, phospholipids and free fatty acids were found to be significantly increased ($p< 0.05$) in cadmium chloride treated group. Whereas, a significant decrease ($p < 0.05$) in the HDL level was found in the cadmium chloride treated group. These levels were found to be restored in the reference drug silymarin (50 mg/kg body weight) and extract pre-treated groups in a concentration dependent manner, with 80 mg/kg body weight to be the most effective concentration (Table 5).

DISCUSSION

Cadmium imposes a major threat to the environment as well as on the health of humans (Hideaki *et al*., 2008). The present study was premeditated to evaluate the effectiveness of *Centella asiatica ethanolic* (Ca) ethanolic leaves extract on cadmium chloride induced toxicity in albino rats. Earlier finding by Antony *et al.* (2006) showed that Ca alcoholic extract had hepatoprotective effect in chemically (CCl_4) induced liver injury. According to the acute toxicity studies of Abdulla *et al.* (2010) the ethanolic extract of Ca at a dose ranging from 2g and 5g per kg body weight for 14 days did not manifest any significant noticeable signs of toxicity. The qualitative phytochemical screening (Table 2) of the extract revealed the occurrence of alkaloids, phenols, flavanoids, quinones, triterpenoids and fixed oils and fats. The qualitative phytochemical results were in agreement with previous studies (Meena *et al*., 2012; Seevaratnam *et al*., 2012 and Ghosh & Indra, 2014)

The cadmium chloride treated animals showed a significant decrease ($p<0.05$) in body weight (Table 3). This result was in agreement with previous work by Milton Prabu *et al*. (2012) who observed a marked decrease in body weight in cadmium chloride treated rats. The cadmium chloride treated animals also showed a significant increase ($p<0.05$) in fasting blood glucose levels (Table 4). Rahman *et al*. (1988) suggested that cadmium exposure for a long time was linked to diabetes mellitus. Cadmium exposure is also commonly associated with pancreatic damage by injuring the beta cells (insulin secreting cells) in islets of Langerhans (Demir *et al*., 2006; Khorasgani *et al*., 2013). Kaltreid *et al*. (2001) also linked low levels of heavy metal to glucocorticoid system impairment.

Glucocorticoid hormones play an important role in glucose, carbohydrate and protein metabolism. These collectively affect increase or decrease in the body weight. This disruption of glucocorticoid system might be the reason for body weight loss in cadmium treated group. The groups administered with reference drug silymarin (50 mg/kg body weight) and Ca ethanolic leaves extract (in a concentration dependent manner), with 80 mg/kg body weight being the most effective concentration, showed a significant restoration of the fasting blood glucose as well as body weight close to normal levels (Table 3 and 4). This might be due to the presence of various compounds with antioxidant properties in *Centella asiatica* (Meena *et al*., 2012; Seevaratnam *et al*., 2012 and Ghosh & Indra, 2014).

The treatment of rats with cadmium chloride significantly increased ($p<0.05$) the levels of total cholesterol, HDL, LDL, VLDL, triglycerides, phospholipids and free fatty acids and also significantly decreased the level of HDL in the serum. In various studies cadmium has been related with dyslipidemia and the results of the present work were also in agreement with these studies (Rogalska *et al*., 2009; Prabu *et al*., 2010). Cadmium is reported to induce alterations in lipid metabolism by increasing the activity of 3-hydroxy-3-methylglutaryl-coenzyme A reductase (HMG-CoA) by the production of inflammatory cytokines as well as interleukins. In various studies, cytokines have been linked with increase in the levels of serum triglycerides and VLDL by inducing hepatic lipogenesis and suppression of oxidation of fatty acids. The results of the present study shows an increase in lipid profile in cadmium chloride treated group which is an indicator of lipid metabolism impairment leading to hypercholesterolemia and hyperlipidemia and are consistent with the results of other authors (Rogalska *et al*., 2009; Prabu *et al*., 2010). The decreased levels of HDL and an increased level of LDL is also an indicator of lipoprotein metabolism due to cadmium exposure in rats. HDL is known for its antiatherosclerotic action and facilitates the removal of cholesterol from blood vessels. Thus, collectively an elevated level of LDL, VLDL, cholesterol and triglycerides elevate the risk of atherosclerosis (Rogalska *et al*., 2009). The elevated levels of free fatty acids in serum may be the result of β oxidation inhibition by cadmium and free fatty acids levels subsequently increase in liver mitochondria, followed by discharge into the circulatory system (Prabu *et al*., 2010). The hypercholesterolemia and

hyperlipidemia conditions in cadmium chloride treated rats were efficiently restored to near normal levels in groups administered with reference drug silymarin (50 mg/kg body weight) and Ca ethanolic leaves extract (in a concentration dependent manner), with 80 mg/kg body weight being the most effective concentration. This may be due to the anti-inflammatory effect of *Centella asiatica* (Seevaratnam *et al*., 2012).

The present study collectively demonstrates that the pre-oral treatment of cadmium chloride treated rats with *Centella asiatica* (Ca) ethanolic leaves extract can substantially reduce the fasting blood glucose levels, hypercholesterolemia, hyperlipidemia, phospholipids and free fatty acids developed due to cadmium treatment and provide future avenues to study the anti-inflammatory molecular mechanisms involved in the protective mechanism of the *Centella asiatica* ethanolic leaves extract and also isolation and characterization of potent molecules responsible for this protective effect.

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References

Abdulla, M.A., AL-Bayaty, F.H., Younis, L.T. and Abu Hassan, M.I. 2010. Anti-ulcer activity of *Centella asiatica* leaf extract against ethanol-induced gastric mucosal injury in rats. Journal of Medicinal Plants Research.., 4(13): 1253-1259.

Antony, B., Santhakumari, G., Merina, B., Sheeba, V., Mukkadan, J., 2006. Hepatoprotective effect of *Centella asiatica* (L) in carbon tetrachloride-induced liver injury in rats. Indian Journal of Pharmaceutical Sciences., 68(6): 772-776.

Bertin, G., Averbeck, D. 2006. Cadmium: cellular effects, modifications of biomolecules, modulation of DNA repair and genotoxic consequences (a review), Biochimie., 88: 1549–1559.

Demir, H., Kanter, M., Coskun, O., Uz, Y.H., Koc, A., Yildiz, A., 2006. Effect of black cumin (*Nigella sativa*) on heart rate, some hematological values, and pancreatic beta-cell damage in cadmium-treated rats. Biol. Trace. Elem. Res., 110(2):151-162.

Falholt, K., Lund, B., Falholt, W., 1973. An easy colorimetric micromethod for routine determination of free fatty acids in plasma. Clin Chim Acta., 46:105–111.

Fossati, P. and Prencipe, L., 1982. Serum triglycerides determined colorimetrically with an enzyme that produces hydrogen peroxide. Clin. Chem. 28: 2077-2080

Friberg, L., Kjellstrom, T., Nordberg, G.F. 1986. Cadmium (Handbook on the Toxicology of Metals) 2 ed L. Friberg, G.F. Nordberg, V.B. Voul, Oxford, Elsevier.

Friedewald, W.T., Levy, R.I., Fredrickson, D.S., 1972. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin. Chem., 18:499-502

Ghosh, K. and Indra, N., 2014. Phytochemistry, *in vitro* free radical scavenging, chelating and toxicity of *Centela asiatica* L. (Apiaceae) Ethanolic Leaf Extract. Int JPharm Sci Rev Res., 29(1): 328-334.

Gidez, W.M., Webb, M., 1950. Revision of cholesterol determination. J Bio Chem. 187:87–106.

Harbone, J.B. 1973. Phytochemical methods. London. Chapman and Hall, Ltd, Pp. 49 188.

Hassan, M.J., Wang, F., Ali, S., Zhang, G. 2005. Toxic effect of cadmium on rice as affected by nitrogen fertilizer form. Plant and Soil., 277 (1-2): 359-365.

Hideaki, S., Yasutake, A., Hirashima, T., Takamure, Y., Kitano, T., Waalkes, M.P., *et al*. 2008. Strain difference of cadmium accumulation by liver slices of inbred Wistar-Imamichi and Fischer 344 rats. Toxicology in Vitro., 22 : 338-43.

International Agency for Research on Cancer, Berrylium, cadmium, mercury and exposures in the glass manufacturing industry, in: International Agency for Research on Cancer Monographs on the Evaluation of Carcinogenic Risks to Humans, vol. 58, IARC Scientific Publications, Lyon, 1993, pp.119–237.

IPCS, Cadmium, Environmental Health Criteria 134. 1992, World Health Organization: Geneva, Switzerland. http://www.inchem.org/documents/ehc/ehc/ehc134.htm.

IPCS, Exposure To Cadmium: A Major Public Health Concern. 2010, World Health Organization, Geneva, Switzerland. http://www.who.int/ipcs/features/Cd.pdf

Kaltreider, R.C., Davis, A.M., Lariviere, J.P., Hamilton, J.W., 2001. Arsenic alters the function of the glucocorticoid receptor as a transcription factor. Environmental Health Perspectives., 109: 245– 251.

Khorasgani, E.M., Haghdoost, I.S., Sedaghat, R., Mortazavi, P. and Roghani, M., 2013. *Satureja hortensis* L. alcoholic extract ameliorates cadmium-induced pancreatic damage in rats. Middle-East J. Sci. Res., 15 (1): 32-35, 2013

Kokate, C.K., 1999. Practical Pharmacognosy. Vallabh Prakashan, New Delhi, 107-21

Meena, H., Pandey, H.K., Pandey, P., Arya, M.C., Ahmed Z. 2012. Evaluation of antioxidant activity of two important memory enhancing medicinal plants *Baccopa monnieri* and *Centella asiatica*. Indian. J. Pharmacol., 44(1): 114–117.

Mukherjee, S., Dugad, S., Bhandare, R., Pawar, N., Jagtap, S., Pawar, P.K., Kulkarni, O. 2011. Evaluation of comparative free-radical quenching potential of Brahmi (*Bacopa monnieri*) and Mandookparni (*Centella asiatica*). Ayu., 32(2): 258-64.

Prabu, S. M., Shagirtha, K. and Renugadevi, J. (2010), Amelioration of Cadmium-Induced Oxidative Stress, Impairment in Lipids and Plasma Lipoproteins by the Combined Treatment with Quercetin and α-Tocopherol in Rats. J Food Sci., 75: T132–T140.

Rahman, M., Tondel, M., Ahmad, S.A., 1998. Diabetes mellitus associated with arsenic exposure in Bangladesh. American Journal of Epidemiology., 148: 198–203.

Rogalska, J., Brzóska, M.M., Roszczenko, A., Moniuszko-Jakoniuk, J., 2009. Enhanced zinc consumption prevents

cadmium-induced alterations in lipid metabolism in male rats. Chem. Biol. Interact., 177(2):142-152.

Sasaki, T., Matsy, S., Sorae, A., 1972. Effect of acetic acid concentration on the colour reaction in the O-toluidine boric acid method for blood glucose estimation. Rinsho Kagarku 1:346-353

Seevaratnam, V., Banumathi, P., Premalatha, M.R., Sundaram, S.P., Arumugam, T., 2012 Functional properties of *Centella asiatica* (L.): A review. Int. J. Pharm. Pharm. Sci., 4(5):8-14.

Trease, E., Evans, W.C. Pharmacognosy. 15th ed. San Diego, CA: Harcourt Publishers Limited; 2002. pp. 343–545.

Trease, G.E. and Evans, W.C., 1983. The text book of pharmacognosy. (12th edn.,) Balliere, Tindall, London, 57-59. 343-383.

Yu Q.L., Duan, H.Q., Takaishi, Y., Gao, W.Y., 2006. A novel triterpene from *Centella asiatica*. Molecules., 11(9): 661-665.

Zilversmit, D.B., Davis, A.K., 1950. Microdetermination of plasma phospholipids by trichloroacetic acid precipitation. J. Lab. Clin. Med., 35(1):155–160.

Zlatkis, A., Zak, B. and Boyle, A.J., 1953. A new method for the direct determination of serum cholesterol. J. Lab. Clin. Med. 41: 486-492.

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