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ANTITUMOR AND ANTIOXIDANT ACTIVITY OF *CLEOME VISCOSA* AGAINST DALTON'S ASCITES LYMPHOMA IN RODENTS

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ABSTRACT

The methanol extract of *Cleome viscosa* (Capparaceae) leaves (MECV) were evaluated for antitumor activity and antioxidant activity against Dalton's ascites lymphoma (DAL)-bearing Swiss albino mice. The extract was administered at the doses of 200 and 400 mg/kg body weight per day for 14 days after 24 h of tumor inoculation. After the last dose and 18 h fasting, the mice were sacrificed. The present study deals with the effect of MECV on the growth of transplantable murine tumor, life span of DAL-bearing hosts, hematological profile, biochemical and antioxidant profile. MECV caused significant decrease in tumor volume, packed cell volume, and viable cell count; and it prolonged the life span of DAL-tumor bearing mice. Hematological profile converted to more or less normal levels in extract-treated mice. The lipid peroxidation was increased in tumor bearing animals, after treatment with MECV antioxidant levels increased significantly. The results indicate that MECV exhibited significant antitumor activity in DAL-bearing mice.

KEYWORDS: Oxidative stress, Transplantable tumors, Anticancer, Dalton's ascites lymphoma, Cleome *viscosa*, Antitumor.

INTRODUCTION

Cancer is the uncontrolled growth of abnormal cells in the body. This results from a series of molecular events that fundamentally alter the normal properties of cells. In cancer cells the normal control systems that prevent cell overgrowth and the invasion of other tissues are disabled. These altered cells divide and grow, display uncontrolled growth, invasion and sometimes metastasis. According to a study by the World Health Organization, one in 12 women in urban India will develop cancer in their lifetime. Approximately 40 per cent of new cases of cancer in India afflict women. Cancer is one of the leading cause to death in the developed and developing countries. [WHO, changing the history, 2004]. Cancer accounted for 7.1 million deaths in 2003 and it is estimated the overall number of new cases will rise by 50% in the next 20 years [WHO, Global action against cancer 2003].

Experimental tumor models have a wide role in anticancer drug discovery. A Dalton's ascites lymphoma (DAL) tumorigenesis model in Balb/c / Swiss albino mice provides a convenient model system to study antitumor activity within a short time [Shankar et al., 2000]. Following transplantation of DAL cells into the abdominal cavity of healthy recipient mice, tumorigenesis begins immediately and aggressively [Goldie et al., 1951; Aptekman et al., 1955]. Free radicals are the chemical species contains at least one 'unpaired of electron'. Reactive oxygen species (ROS) are the free radicals associated with the oxygen atom or their equivalents and have stronger reactivity with other molecules than with molecular oxygen (O_2). ROS usually indicate the major following four species: (i). Superoxide anion radical ($O_2^{\cdot-}$); (ii) hydrogen peroxide (H_2O_2); (iii) hydroxyl Radical ($^{\cdot}OH$); and (iv). Singlet oxygen ($^1O_2$). (H_2O_2) and ($^1O_2$) are not free radicals by definition but they behave like free radicals.

Free radicals are implicated in many pathological conditions by irreversibly damaging the structure of biological molecules like cell membranes, DNA, Proteins etc. These free radicals can directly interacting with DNA produce single or double strand DNA breaks, DNA cross linking, purine, pyrimidine, or deoxyribose modifications, and DNA cross-links. Persistent DNA damage can result in either arrest or induction of transcription, induction of signal transduction pathways, replication errors, and genomic instability, all of which to cancer. [Marian et al., 2004]. Plants are the rich source of medicines from ages. They produce bioactive molecules which can used to ameliorate various types of disorders. Over the last few decades there has been increased interest by pharmaceutical industries to discover the new drugs from the ethnobotanicals to provide new and alternative drugs to synthetic drugs for treatment of dreadful diseases. Potent anticancer drugs like taxol, vinblastine, vincristine, the camptothecin derivatives, topotecan and irinotecan, and etoposide derived from plant sources and they are in efficient clinical use. *Cleome viscosa* (Family: Capparaceae) is a widely distributed herb with yellow flowers and long slender pods containing seeds.

The whole plant is used as drugs by the traditional medical practitioners in India with beneficial action for the treatment of diarrhoea, fever, inflammation, liver diseases, bronchitis, skin diseases, and malarial fever. The plant contains lignans, flavonoids, saponins, ascorbic acid, and polyunsaturated fatty acid. Coumarino lignin glycosides cleomiscosins has isolated from seeds of *C.viscosa.*[Ray et al.,1985]. Some other chemical constituents isolated from *C. viscosa* are glucosinolates [Songsak et al., 2002], cleomeolide, Stigmasta-5,24(28)-diene-3β-*O*-α-L-rhamnoside [Srivastava et al.,1980], kaempferide-3-glucuronide [Chauhan et al.,1979], and naringenin glycoside [Srivastava et al.,1979].

Traditionally described medicinal uses of *C.viscosa* are laxative, anti-helminthic, stomachic, and diuretic. It can be also used in treatment of malarial fevers, skin diseases, leprosy and fever due to indigestion, blood disorders and uterine complications [Kirtikar et al.,1984]. Earlier pharmacological reports of *C.viscosa* were indicating that it has proved to be act as hepatoprotective [Sengottuvelu et al.,2007], antihelminthic [Mali et al., 2007], analgesic [Parimala Deviet al.,2004], anti-inflammatory [Saxena et al., 2000], immunomodulatary
[Tiwari et al., 2004, Bawankule et al., 2007], mutagenic [Polasa et al., 1987]. Since it has a number of medicinal properties including free radical scavenging activity. Hence, in the present study the methanolic extract of *C.viscosa*has been evaluated for antitumor activity in DAL bearing mice.

MATERIALS AND METHODS

Plant material

The plant *Cleome viscosa* (Family: Capparaceae) was collected in the month of October 2010 From the Talakona forest, Chittor district. The plant material was taxonomically identified by the taxonomist, S.V University, Tirupathi. The dried powder material of the leaves of the *Cleome viscosa was* extracted with methanol (yield 10.5%) in a soxhlet apparatus. The methanol extract was then distilled, evaporated, and dried in vacuum. Preliminary qualitative analysis of the methanol extract showed the presence of steroids, triterpenoids and flavonoids. The methanol extract of *Cleomeviscosa (*MECV) was used for the present study.

Experimental Animals

The study was carried out after obtaining permission from Institutional animal ethics committee (No. 160/SPIPS/Wgl/IAEC/2011) and CPCSEA regulations were adhered to during the study. Male Swiss albino mice (20- 25 g) were selected for this study. The animals were maintained under standard environmental conditions and fed with standard pellet feed and water *ad libitum.*

Tumor cells

DAL cells were obtained from Amala Cancer Institute, Thrissur, Kerala, India. . The DAL cells were maintained by intraperitoneally inoculation of 2×10^6 cells /mouse. Ascitic fluid was drawn out from DAL tumor bearing mouse at the log phase (days 10–12 of tumor bearing) of the tumor cells.

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Each animal received 0.2 ml of tumor cell suspension containing 2×10^6 tumor cells intraperitoneally.

Treatment schedule

60 male Swiss albino mice were divided into five groups (n = 10) and given food and water *ad libitum*. All the animals in each groups except Group-I received DAL cells (2×10^6 cells/mouse i.p.) This was taken as day '0'. Group-I served as normal control (25% Tween 80 per oral) and Group-II served as DAL control. 24-h after DAL transplantation, Group-III and Group-IV received methanol extract of *C.viscosa*(MECV) at a dose of 200 and 400 mg/kg/oral for 14 consecutive days, respectively. Group-V received reference drug 5-fluorouracil (20 mg/kg oral) for 14 consecutive days [Muthu et al., 2010]. 24 hours of last dose, 5 animals of each group were sacrificed to study the tumor growth parameters (mean survival time, viable, non-viable cell, tumor volume, tumor weight and tumor packed cell volume), antioxidant and hematological parameters and the rest were kept with food and water *ad libitum* to check percentage increase in life span of the tumor host.

In Vitro-cytotoxicity study

DLA cells ($1x10^{6)}$ in phosphate buffer saline (PBS) and different concentrations (50,100, 200, 400, 600,800, 1000, 1600 ug/ml) of MECV were incubated at 37º c for 3 hrs in 5% CO_2 atmosphere in the filtered cap, flat bottom cell culture flasks. The viability of cells was determined by Trypan Blue dye exclusion method [Sheeja et al., 1997].

$$\% \text{ cell viability} = \frac{\text{No.of Dead cells}}{\text{No.of viable cells + No.of dead cells}} X100$$

Tumor growth parameters

Tumor volume and weight

After 14 days of treatment, mice were dissected and the ascetic fluid was collected from peritoneal cavity. The volume was measured by taking it in a centrifuge tube and weighed immediately [Moulisha et al., 2010].

Viable and non-viable tumor cell count

The viability and nonviability of the cell were checked by trypan blue dye exclusion assay. The cells were stained with trypan blue (0.4% in normal saline) dye. Live (viable) cells actively pump out the dye by efflux mechanism where as dead (non-viable) cells do not. The number of viable and nonviable cells was counted [Bala et al., 2010].

$$\text{Cell count} = \frac{\text{Number of cells} \times \text{dilution factor}}{\text{Area} \times \text{thickness of liquid film}}$$

Tumor packed cell volume

The ascitic fluid was collected into Wintrobe's tube and it was centrifuged at the rate of 3000 rpm for a period of one hour. The volume of packed cells read directly as percentage. [Sur et al. 1994].

Percentage increased in life span

The effect of MECV on percentage increases in life span was calculated on the basis of mortality of the experimental mice [Muthu et al., 2010].

$$\text{ILS (\%)} = \left[\frac{\text{Mean survival time of the treated group}}{\text{Mean survival time of the control group}} - 1\right] X100$$

$$\text{Mean survival time}^* = \frac{\text{First death + last death}}{2}$$

* Time denoted by days.

Hematological parameters

At the end of the experimental period, blood was collected from retrorbitalpluxes and used for the estimation of hemoglobin (Hb) content , red blood cell (RBC) count , white blood cell (WBC) count , packed cell volume (PCV) and differential count [Armour et al.,1965, Wintrobe et al.,1961 , Dacieet al., 1958] by standard procedures.

Biochemical parameters

The remaining blood was centrifuged and serum was used for the estimation of liver biochemical parameters like Serum glutamic pyruvic transaminase (SGPT) [Bergmeyer et al., 1986a], Serum glutamic oxaloacetic transaminase (SGOT) [Bergmeyer et al., 1986b], Albumin [Doumas et al., 1971] Total protein (TP) [Doumas et al., 1975; Gornall et al., 1949] .

Antioxidant activity

The liver was excised, rinsed in ice cold normal saline followed by cold 0.15M Tris-Hcl (pH 7.4), blotted and weighed. The homogenate was processed for estimation of Lipid peroxidation (LPO) [Okhawa et al.,1979], Superoxide Dismutase (SOD) [Arutla et al., 1998], Catalase (CAT) [Beer et al., 1952], Reduced glutathione (GSH) [Ellman et al., 1959], Glutathione peroxidase (GP_X) [Rotruck et al., 1973], Glutathione-S-Transferase (GST) [Habig et al., 1974].

Effect of on normal peritoneal cell count

To evaluate effect of MECV on normal peritoneal cells, 3 groups of normal mice (n= 4) were taken. One group was treated with 400 mg/kg p.o. of MECV and the second group received the same treatment for 2 consecutive days. The untreated third group was used as control. Peritoneal exudate cells were collected after 24 h treatment by repeated intraperitoneal wash with normal saline and counted in each of the treated groups and compared with those of the untreated group [Sur et al., 1994].

Effect of on solid tumor

Mice were divided into two groups (n = 4). DAL cell lines ($1x10^6$cells/mice) were injected into right hind limb (thigh) of all mice intramuscularly. The Group I used as DAL tumor control. The Group II treated with MECV 400 mg/kg/oral for 14 days. Tumor mass was measured from 15^{th} day of tumor induction. The measurement was carried out every 5^{th} day for a period of 30 days. Tumor mass volume was measurement using following formula $V=4/3\pi r^2$, where r is the mean of r1 and r2 which are two independent radii of the tumor mass [Rajeshkumar et al., 2002].

Statistical analysis

All data are expressed as mean ± S.E.M. Statistical significance (*p*) calculated by ANOVA followed by Dennett's (tumor volume, tumor weight, viable, non viable, mean survival time, tumor PCV) and Benferroni tests (hematological, SGPT, SGOT, Total Protein, albumin, Antioxidant parameters). $P<0.05$ was considered as statistically significant.

RESULTS

In Vitro-cytotoxicity study

The In vitro cytotoxicity effect of MECV at various concentrations 50, 100, 200, 400, 600, 800, 1000, 1600 ug/ml on DAL cell lines using tryphan blue dye exclusion assay method has shown in the table 1. the percentage of cell viability 10 % , 25 %, 30 %, 42 % , 54 % , 70 %, 85 % , 92 % respectively. The IC_{50} value was found to be 650 ug/ml.

Effect of MECV on mean survival time

The effect of MECV on mean survival time were shown in table 1, On oral treatment of MECV to the tumor induced DAL mice, the mean survival time of DAL control group was found to be 12.5±0.96, while it increased to 19.4 ± 0.58 (MECV 200 mg/kg), 23.5 ± 2.14 (MECV 400 mg/kg) respectively in MECV treated groups and whereas the standard drug 5-fluorouracil (20 mg/kg)-treated group had a mean survival time 26.9 ± 2.06

Effect of MECV on tumor growth

The effect of MECV on tumor growth response were shown in table 1, after treatment with MECV (200 and 400 mg/kg) significantly ($P< 0.01$, $P<0.001$) reduced the tumor volume, viable tumor cell count and ($P<0.05$, $P<0.01$) tumor packed cell volume in a dose-dependent manner as compared to that of the DAL Control group. Furthermore, nonviable

tumor cell count at different doses of MECV were significantly (P<0.01) increased in a dose-dependent manner.

Table 1: Effect of methanol extract of *Cleome viscosa*on tumor growth parameters

Parameters	DAL	DAL + MECV 200 mg/kg	DAL+ MECV 400 mg/kg	DAL + 5-FU 20 mg/kg
Mean survival time(days)	14.2±0.96	19.4±0.58	23.5±2.14*	26.9±2.06**
Increased life span (%)	---	31	46*	61*
Tumor volume(ml)	16±2.7	12.4±2.13**	4.7±0.91***	4.8±1.29***
Tumor packed cell volume (ml)	51.62±2.9	33.51±1.4**	35.7±1.5**	31.3±2.4**
Viable cell count(x10^{7}cells/ml)	18.63±0.96	17.91±0.83*	12.38±0.7**	12.65±0.68**
Nonviable cell count (x10^{7}cells/ml)	0.15±0.017	0.25±0.02*	0.42±0.07**	0.75±0.06**

Data are expressed as the mean ± SEM. n= 5. *P<0.05, **P<0.01, ***P<0.001, extract-treated groups compared with the DAL Group.

Effect of MECV on hematological parameters

The effect of MECV on hematological parameters were shown in table 2, Hemoglobin content (P< 0.05) and RBC count in the DAL control group was decreased as compared to the normal control group. After treatment with MECV at various doses 200 mg/kg, 400 mg/kg significantly (P<0.01) increased the hemoglobin content and RBC count and brought up to the near or less to the normal levels. The total WBC counts and PCV (P<0.001) was found to be increased significantly in the DAL control group when compared with the normal group. Administration of MECV in DAL-bearing mice significantly reduced the WBC count and PCV (P<0.05) as compared with the DAL group. In a differential count of WBC, the presence of neutrophils increased, while the lymphocyte, eosinophils, monocytes counts decreased in the DAL. Treatment with MECV at different doses changed these altered parameters more or less to the normal values.

Table 2: Effect of methanol extract of *Cleome viscosa*on hematological parameters

Parameters	Control	DAL	DAL + MECV 200 mg/kg	DAL+MECV 400 mg/kg	DAL +5-FU 20 mg/kg
Hemoglobin (%)	14.5±0.46	6.3±1.22^a	7.93±0.49^e	10.41±0.59^e	9.66±0.99^e
RBC(x10^{6}cell/mm^3)	12.2±0.56	7.9±0.4^a	8.1±0.5^e	10.52±0.39^e	12.5±0.60^e
PCV (%)	29.8±4.13	43.22±3.61^c	35.5±3.45^d	24.98±1.32^d	22.62±1.57^d
WBC(x10^{4}cells/mm^3)	0.57±0.13	5.44±0.7^c	3.48±0.21^d	1.4±0.14^d	1.51±0.17^d
Neutrophils (%)	37.6±1.74	53.8±7.01^b	52.1±1.88	40.6±0.7^e	38.4±1.69^e
Lymphocytes (%)	61.4±2.33	46±5.07^a	39.6±1.28	46.2±1.06	45.2±2.43
Eosinophils (%)	3.2±1.03	1.5±0.4	2.5±0.67	3.4±5..0	4.4±1.03
Monocytes (%)	1.5±0.37	0.2±0.2	0.2±0.2	0.2±0.2	0.8±0.37

Data are expressed as the mean ± SEM, n=5. ^{a}*P*<0.05, ^{b}*P*<0.01, ^{c}*P*<0.001, Control Vs DAL.^{d}*P*<0.05,^{e}*P*<0.01 and ^{f}*P*<0.001, DAL Vs extract treated groups

Effect of MECV on biochemical parameters

As shown in table 3, SGOT, SGPT, albumin levels were increased significantly (P<0.01) and total protein levels were decreased (P<0.05) as when DAL control group compared to the normal control group. After treatment with MECV at the dose of 200 mg/kg, 400mg/kg and 5 FU significantly decreased the elevated SGOT, SGPT, albumin to normal levels and increased total protein levels.

Table 3: Effect of methanolic extract of *Cleomeviscosa*on biochemical parameters

Parameters	Control	DAL	DAL + MECV 200 mg/kg	DAL+ MECV 400 mg/kg	DAL +5-FU 20 mg/kg
SGPT(U/L)	22.6±1.7	51.8±2.49^b	37.4±7.9^c	31.5±0.78^d	31±1.70^d
SGOT(U/L)	112.6±27.6	173.8±15.1^b	156.8±3.1^c	122.8±1.24^c	83.4±1.86^e
Albumin(gm %)	2.2±0.64	12.2±0.2^b	3.4±0.32^e	2.5±0.17^e	2.24±0.128^e
Total Protein (gms%)	5.28±0.64	2.8±0.31^a	3.51±0.95^a	4.72±0.84^b	6.3±0.57^b

Data are expressed as the mean of results in 5 mice ± SEM. ^{a}*P*<0.05 and ^{b}*P*<0.01, DAL Vs normal control,^{c}*P*<0.05 and ^{d}*P*<0.01,^{e}P< 0.001 extract treated Groups Vs DAL group.

Effect of MECV on antioxidant activity

As shown in Table 4, in the DAL group, the LPO level was increased and SOD,CAT, reduced GSH,GP$_X$, GST levels were decreased significantly (P<0.001) as compared to the normal control. After treatment with MECV at different doses (200 mg/kg, 400mg/kg and 5-FU significantly decreased the LPO and increased the SOD, CAT, reduced GSH, GP$_X$, GST levels.

Effect of MECV on normal peritoneal cells

The average number of peritoneal exudate cells per normal mouse was found to be 4.9x10^6. MECV (400 mg/kg) single treatment enhanced peritoneal cells to 9.4x10^6 while two consecutive treatments enhanced the number to 13.57 x 10^6.

Effect of MECV on solid tumor growth

There was reduction in the tumor volume of mice treated with MECV 400 mg/kg from 15th day to 30th day. On 30th day tumor volume of DAL control animals was 6.4±1.13 ml, whereas for the extract-treated group it was found to be 0.03±0.22 ml as shown in Table 5.

DISCUSSION

The present study was carried out to evaluate the antitumor effect of MECV in DAL-bearing mice. The MECV-treated animals at the doses of 200 and 400 mg/kg significantly inhibited the tumor volume, packed cell volume, tumor cell count, and brought back the hematological parameters to more or less normal levels. In DAL-bearing mice, a regular rapid increase in ascites tumor volume was noted. Ascites fluid is the direct nutritional source for tumor cells and a rapid increase in ascites fluid with tumor growth would be a means to meet the nutritional requirement of tumor cells [Prasad et al.,1994]. Treatment with MECV increased the percentage of tryphan blue positive stained dead cells in tumor bearing mice. The reliable criteria for judging the value of any anticancer drug are the prolongation of the life span of animals [Clarksonet al., 1965]. The MECV decreased the ascites fluid volume, viable cell count, and increased the percentage of life span. It may be concluded that MECV by decreasing the nutritional fluid volume and arresting the tumor growth, this could be the reason for the increase life span of DAL-bearing mice. Usually, in cancer chemotherapy the major problems that are being encountered are of myelosuppression and anemia [Hogland et al., 1962, Price et al., 1958]. The anemia encountered in tumor bearing mice is mainly due to reduction in RBC or hemoglobin percentage, and this may occur either due to iron deficiency or due to hemolytic or myelopathic conditions [Fenninger et al., 1954]. After the repeated treatment, MECV able to reverse the changes in hematological parameters hemoglobin content, RBC, and WBC counts near to normal levels. This indicates that MECV is showing protective action on the hemopoietic system.

The generation of free radicals in vivo is a constant phenomenon due either to physiological metabolism or pathological alterations. These generated free radicals are the main cause of lipid peroxidation which is an autocatalytic free radical chain propagating reaction, is known to be associated with pathological conditions of a cell [Gat et al., 1999]. The oxidation of proteins, lipids, nucleotides and carbohydrates causes chemical modification, leads to damage of above. Malondialdehyde is the end product of lipid peroxidation, was reported to be more in cancerous cells when compared to non cancerous cells [James et al., 2004]. Cells have developed enzymatic systems (antioxidant enzymes) like SOD, catalase and glutathione which convert oxidants into non-toxic molecules, thus protecting the organism from the deleterious effects of oxidative stress. Glutathione (a tripeptide), usually the most prevalent intracellular thiol, functions directly or indirectly in a variety of cellular processes. Reduced

glutathione (GSH) plays an important role in defense mechanisms by acting as an antioxidant or by reacting with electrophiles [Deleve et al., 1991] and toxic agents to form conjugates that are eliminated from the cell [Meister et al., 1991]. SOD, CAT, and glutathione peroxides are involved in the clearance of superoxide and hydrogen peroxide (H_2O_2). SOD catalyses the diminution of superoxide into H_2O_2, which has to be eliminated by glutathione peroxidase and/ or Catalase [Rushmore et al., 1993]. The inhibition of SOD and CAT activities as a result of tumor growth was also reported [Sun et al., 1989]. Similar findings were observed in the present investigation with DAL-bearing mice. MECV significantly reduced the lipid peroxidation and increased the glutathione levels in the DAL bearing drug treated mice. As above stated like the decreased levels of SOD, Catalase and GPx levels were observed in the present study, after drug treatment with different doses the levels of these enzymes were significantly increased.

Natural antioxidants are playing a great role in free radical scavenging activity .Some triterpenoids and flavonoids are found to havepromising anticancer and antioxidant activity. [Hirano et al., 1989]. MECV shows the presence of triterpenes and flavonoids which may act as anticancer and antioxidant principles in the diseased condition [Petronelli et al., 2009]. In our earlier studies, we found that MECV possess hepatoprotective and antioxidant properties [Sengottuvelu et al., 2007]. The free radical hypothesis supported the fact that the antioxidants effectively inhibit the tumor, and the observed properties may be attributed to the antioxidant and antitumor principles present in the extract.

Table 4: Effect of methanolic extract of *Cleome viscosa* on antioxidant parameters:

Parameters	Control	DAL	DAL + MECV 200 mg/kg	DAL+ MECV 400 mg/kg	DAL +5-FU 20 mg/kg
LPO (ng of MDA/mg protein)	0.22±0.02	2.04±0.29[a]	0.81±0.06[b]	1.41±0.15[c]	1.64±0.15[c]
SOD (U/mg protein)	0.18±0.02	0.015±0.01[a]	0.08±0.006	0.15±0.01[b]	0.16±0.01[b]
CAT (U/mg protein)	0.96±0.13	0.13±0.01[a]	0.36±0.04	0.62±0.05[c]	0.73±0.07[c]
GSH (mg/g wet tissue)	0.73±0.14	0.33±0.08[a]	0.48±0.17[d]	0.59±0.16[c]	0.59±0.17[c]
GP_X (U/mg protein)	0.028±0.003	0.0016±0.005[a]	0.005±0.0003	0.018±0.001[d]	0.019±0.003[d]
GST (U/mg protein)	0.026±0.003	0.005±0.0006[a]	0.017±0.000[d]	0.015±0.004[c]	0.019±0.003[c]

Data are expressed as the mean ± SEM. [a]P<0.001, DAL Vs Control.[b]P<0.001,[c]P<0.01 and [d]P<0.05, DAL Vs extract treated groups.

Table 5: Effect of *Cleome viscosa*on solid tumor growth:

	Solid tumor volume in ml			
Groups	**15th day**	**20thday**	**25thday**	**30th day**
DAL control	0.076±0.01	2.5±0.3	3.9±0.7	6.3±1.19
MECV 400	0.23±.007	0.17.±0.16	0.07.±0.09**	0.03±0.22***

Data are expressed as the mean of results in 4 mice ± SEM. **P<0.01, ***P<0.001, MEDP 400 Vs DAL Group

CONCLUSION

The present study demonstrates that MECV increased the life span of DAL-tumor bearing mice. and decreased the lipid peroxidation and thereby augmented the endogenous antioxidant enzymes in the liver. The above parameters are responsible for the antitumor and antioxidant activities of *Cleome viscosa*.

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