Anti-nephrotoxic effect of administration of Moringa oleifera Lam in amelioration of DMBA-induced renal carcinogenesis in Swiss albino mice

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Abstract
Moringa oleifera Lam. (Moringaceae) is highly valued plant reported to have various biological activities. Considering the antioxidant properties of Moringa oleifera (MO), the chemopreventive property of hydro-ethanolic extract of drumsticks was evaluated on DMBA induced renal carcinogenicity. Groups of 10 male mice were pre-administered with MO (200 and 400mg/kg body weight) and standard (0.5%BHA) for 14 days prior to a single dose of DMBA (15mg/kg; p.o). The therapeutic efficacy of drumstick extract was observed in terms of normalization of altered renal oxidative stress parameters like LPO, SOD and CAT in kidney of mice. DMBA exposure elicited a significant escalation in LPO level and depletion in antioxidant enzymes namely superoxide dismutase and catalase. Investigated parameters were restored, nearly to the normal values, after MO extract treatment. These results suggested that MO extract could act against DMBA-induced kidney injury in mice by a mechanism related to its antioxidant properties.

Keywords: Moringa oleifera; oxidative stress; chemoprevention; antioxidant property.

Introduction
Medicinal plants have been used by all civilizations as a source of medicines since ancient times. In the recent times, there has been growing interest in exploiting the biological activities of different ayurvedic medicinal herbs, due to their natural origin, cost effectiveness and lesser side effects (Naik et al., 2003). Interest in medicinal plants as a re-emerging health aid in the maintenance of personal health and well-being has been fuelled by rising costs of prescription drugs, and the bioprospecting of new plant-derived drugs (Sharma et al., 2010).

Active oxygen species and free radicals play an important role in the pathogenesis of several human diseases, such as rheumatoid arthritis, and cardiovascular diseases (Hertog et al., 1997) including cancer. The antioxidant defense enzymes have been suggestive of playing an important role in maintaining physiological levels of oxygen and hydrogen peroxide and eliminating peroxides generated from inadvertent exposure to xenobiotics and drugs. Any natural compound with antioxidant properties may help in maintaining health when continuously taken as components of dietary foods, spices or drugs (Singh, 2000).

Among myriad of plants, Moringa oleifera Lam is one of the best known and most distributed species of Moringaceae family. Moringa is an important tropical crop that is used as human food, medicine and in oil production (Anwer et al., 2007). Leaves of this plant are traditionally known for or reported to have various biological activities, including hypcholesterolemic agent (Ghasi et al., 2000), regulation of thyroid hormone status (Tahiliani and Kar, 2000), anti diabetic agent (Makonnen et al., 1997), gastric ulcers (Pal et al., 1995), antitumor agent (Bharali et al., 2003), antihyperglycemic (Anwar et al., 2007) and hypotensive agent (Faizi et al., 1995). The leaves as well as the flowers, roots, gums, fruits and seeds are extensively used for treating inflammation (Mahajan and Mehta, 2008), cardiovascular action, liver disease (Rao and Misra,1998) and hematological, hepatic and renal function (Mazumder et al., 1999). It is generally known in the developing world as a vegetable, a medicinal plant and a source of vegetable oil (Bennet et al., 2003).

Epidemiological studies suggest that specific pharmacologically active agents present in the diet might reduce the relative risk of cancer development (Tanaka et al., 2001). A remarkable surge of interest in chemoprevention research has led to the identification of many phytochemicals of dietary origin as effective potential chemopreventive agents (Bharali et al., 2003). The synthetic polycyclic aromatic hydrocarbon 7,12-dimethylbenz(a)anthracene (DMBA) is a...
potent carcinogen which is selectively active in sites such as mammary glands, skin, kidney and liver, and has been widely used as a prototype carcinogen in experimental animal models. After exposure to DMBA, stable DNA-carcinogen adducts may be found in various tissues including the kidney, liver and mammary gland (Song et al., 2000) and protein adducts of serum albumin and haemoglobin are formed as well.

Antioxidant systems are being shown to play an increasing role in the protection against exogenous oxidative stress. There are two basic categories of antioxidant namely synthetic and natural ones. Restriction on the use of synthetic anti-oxidants is being imposed because of their carcinogenicity (Mishra et al., 2009). Thus, there is an urgent need to develop potent anti-nephrotoxic and antioxidant especially among natural product agents against DMBA-induced renal disorders. DMBA exposure induces clinicopathological changes through toxicity occurred to skin, mammary glands, liver and kidney characterized by tubular, interstitial and glomerular damages including renal lesions, tumors and cancer risks. Emerging evidences suggest that DMBA induces the production of reactive oxygen species (ROS) that result in lipid peroxidation. DNA damage, and depletion of cell antioxidant defense systems (Bharali et al., 2003). Change in lipid peroxidation production reactions and antioxidant defense systems were associated with changes in a variety of biochemical pathways. A positive correlation has been established between dietary supplementation with certain vegetables and plants and the reduction of toxic effects of various toxicants, environmental agents including carcinogens and heavy metals (Nandi et al., 1997; Sharma et al., 2010). In the light of aforementioned medicinal properties of *Moringa oleifera*, the present investigation was conducted to determine whether the treatment of DMBA exposed mice with *M. oleifera* hydro-ethanolic pod extract could protect the vital organ kidney from DMBA associated oxidative stress.

### Materials and Methods

#### Chemicals

All chemicals used in the study were of analytical reagent grade and of highest quality available and were purchased from reliable firms like SRL (India), MERCK, RANBAXY, HIMEDIA, QUALIGENS (Mumbai) and SUYOG. DMBA was purchased from SIGMA. Standard kits for LPO, SOD and CAT were obtained from Cayman Chemicals, USA.

#### Experimental plant

The experimental plant *Moringa oleifera* was collected from Krishi Vigyan Kendra, Banasthali University, Banasthali, Tonk district, Rajasthan, India. The plant material was taxonomically identified by botanist of Krishi Vigyan Kendra, Banasthali, Tonk district.

#### Hydro-ethanolic extraction of plant material

Dried powdered pods were placed in the Soxhlet thimble with 80% ethanol in 250 ml flat bottom flask and further refluxed for 18 hours at 80°C for two days. Collected solvent was cooled at room temperature and poured in a glass plate. The extract was concentrated under vacuum at 40°C to yield a semisolid mass, dried in hot air oven below 50°C for 48 hours and stored in a dessicator. The percentage yield of extract was found to be 15.6% and stored at 25°C in airtight containers. Suspensions of the extract was prepared in distilled water and used to assess renoprotective and antioxidant activity.

#### Experimental animals

Male Swiss albino mice (*Mus musculus*) weighing 15-30 g were obtained from Haryana Agricultural University, Hisar (India) for experimental purpose. The animals were acclimatized for a month prior to experiment. The Institutional Animal Ethical Committee approved the animal studies. All experiments were conducted on adult male albino mice when they weighed 25-35g (3-4 months old). Colony bred adult male albino mice were maintained under standard laboratory conditions at a temperature of 22 ± 3°C, relative humidity of 50±5 % and photoperiod of 12h (12h-dark and 12h-light cycle). The mice were housed in polypropylene cages. In order to avoid diurnal variation all the experiments were carried out at same time of the day. Animals lead free access to standard food pellet diet (Hindustan Lever Limited: metal contents in parts per million dry weight: Cu 10.0, Zn 45.0, Mn 55.0, Co 5.0, Fe 75.0) and drinking water ad libitum throughout the study. Essential cleanliness and, to the best extent, sterile condition were also adopted according to SPF facilities.

#### Acute toxicity studies

Acute oral toxicity was performed as per OECD-423 guidelines (Ecobichon, 1997). The albino mice were fasted overnight provided only water, after which the hydro-ethanolic extract of the pods of MO was administered by...
gastric intubation to the relevant animals at the single dose of 15 mg/kg body weight. The animals were then observed for 14 days. However, mortality was not observed, the procedure was repeated for further higher doses such as 50, 100, 150, 200, 300, 400, 800, 1600 mg/kg body weight. Mortality was not noticed up to 400 mg/kg, whereas, the LD<sub>50</sub> of the extract was found to be 1800 mg/kg body weight. Toxic symptoms for which the animals were observed for 72 h include behavioral changes, locomotion, convulsions and mortality.

**Experimental design**

Adult Swiss albino male mice divided into six groups of 10 mice each were treated by oral gavage. Treatment consisted of pretreatment phase of MO in distilled water followed by the second phase in which the animals were given 15 mg/kg DMBA on day 15. The animals were then euthanized 4 days after DMBA administration. The groups were as follows:

- **Group 1**: served as control (normal untreated mice), and received 1 ml distilled water daily by oral gavage.
- **Group 2**: received pretreatment with distilled water for 14 days prior to a single dose of DMBA (15 mg/kg body weight: p.o.) served as DMBA control group.
- **Group 3 and 4**: were administered with hydroethanolic extract of pods of MO (200 and 400 mg/kg body weight: p.o.) daily for 14 days, served as MO treated control group.
- **Group 5**: received BHA (0.5 % mg/kg body weight: p.o.) daily for 14 days, dissolved in 0.5% acetone and served as standard treatment group.
- **Group 6 and 7**: were treated with hydroethanolic extract of pods of MO (200 and 400 mg/kg body weight; p.o.) daily for 14 days, before being intoxicated with DMBA (15 mg/kg body weight; p.o, once) dissolved in olive oil.
- **Group 8**: received BHA (0.5 % mg/kg body weight; p.o.) daily for 14 days, before being intoxicated with DMBA (15 mg/kg body weight; p.o, once) dissolved in olive oil. The dose for DMBA, standard antioxidant, and plant was decided and selected on the basis of LD<sub>50</sub> calculated in the laboratory and other published reports (Song et al., 2000; Bharali et al., 2003).

**Nephroprotective activity**

After 19 days of duration, the mice were fasted overnight and then sacrificed under light ether anaesthesia. Kidney were dissected out, washed immediately with ice-cold saline to remove blood, and the wet weight noted and then stored at -80°C for various biochemical assays, and histological studies. Half of each kidney was processed for biochemical analysis and the other half was used for histological examination. The enzyme levels were assayed using standard CAYMAN Chemicals assay kits, U.S.A.

**Preparation of kidney homogenate**

Kidney homogenate was prepared in cold 50 mM potassium phosphate buffer (pH 7.4), for LPO but for SOD and CAT, 1 mM EDTA was added in it, using REMI homogenizer. The unbroken cells and debris were removed by centrifugation at 10,000 rpm for 15 min at 4°C using a REMI cooling centrifuge and the supernatant was used for the estimation of LPO, SOD, and CAT.

**Renal oxidative stress parameters**

**Estimation of lipid peroxidation (LPO)**

Cayman’s Lipid Hydroperoxide Assay Kit measures the hydroperoxides directly utilizing the redox reactions with ferrous ions (Mihaljevic et al., 1998). In brief, 0.5 ml of sample was treated with 1 ml of chloroform and centrifuged at 1500g for 5 min. The supernatant was collected and used for assay. The chloroform-methanol solvent (degassed, 2:1, 0.45 ml) was added to 0.5 ml of supernatant followed by addition of 50 μl chromagen and incubation for 5 min. Lipid hydroperoxide standards (50 μM ethanolic solution of 13-hydroperoxy octadecadienoic acid) were prepared at different concentrations (0-5 nmol) in chloroform-methanol solvent. The absorbance was measured at 500 nm against reference blank (chloroform-methanol solvent). The LPO was expressed as μM/gm of protein.

**Superoxide dismutase (SOD)**

The tissue SOD activity was assayed following the procedure of Cayman’s Superoxide Dismutase Kit, which utilizes a tetrazolium salt for detection of superoxide radicals (Marklund, 1980). Kidney homogenate (10 μl) was taken, and 200 μl of dilute radical detector (24 μM NBT) were added. The reaction was initiated by adding 20 μl of xanthine oxidase (50 μl in 1.95 ml 50 mM Tris-HCl, pH 8.0) to all the wells. The control was simultaneously run without kidney homogenate. SOD standard (bovine erythrocyte SOD) was prepared at different concentrations (0-0.25 U/ml) in 50 mM Tris-HCl, pH 8.0. The plate was incubated for 20 min and the absorbance was measured at 440-460 nm using plate reader. The enzyme activity was expressed as unit ml<sup>-1</sup> and 1 unit of enzyme is defined as amount of enzyme...
needed to exhibit 50% dismutation of the superoxide radical.

**Catalase (CAT)**

Catalase activity in the kidney was assayed following the procedure of Cayman Catalase Assay Kit, which utilizes the peroxidative function of CAT for determination of enzyme activity (Johansson et al., 1988; Wheeler et al., 1990). Kidney homogenate (20 μl) was taken with 30 μl of methanol and 100 μl of assay buffer (100 mM potassium phosphate, pH 7.0) in two wells. Formaldehyde standards were prepared by addition of 20 μl formaldehyde (4.25 mM) at different concentrations instead of samples. The reaction was initiated by the addition of 20 μl of H₂O₂ (30 mM). Blank, without kidney, homogenate was prepared with 100 μl of phosphate buffer and 20 μl of H₂O₂. The plate was incubated on shaker for 20 min. The reaction was terminated by adding 30 μl of potassium hydroxide (10 M) to each well and then 30 μl of purpled (chromogen) was added to each well. This was followed by incubation for 10 min and addition of 10 μl potassium periodate to each well. Formaldehyde standards were prepared by addition of 20 μl formaldehyde (4.25 mM) at different concentrations instead of samples. The reaction was initiated by the addition of 20 μl of H₂O₂ (30 mM). Blank, without kidney, homogenate was prepared with 100 μl of phosphate buffer and 20 μl of H₂O₂. The plate was incubated on shaker for 20 min. The reaction was terminated by adding 30 μl of potassium hydroxide (10 M) to each well and then 30 μl of purpled (chromogen) was added to each well. This was followed by incubation for 10 min and addition of 10 μl potassium periodate to each well. The decrease in optical density due to decomposition of H₂O₂ was measured at the end of 5 min against the blank at 540 nm using plate reader. One unit of activity is equal to the mol of H₂O₂ degraded min⁻¹ protein at 25°C.

The specific activity expressed in terms of units per mg of proteins.

**Statistical analysis**

The experimental results obtained are expressed as mean ± standard deviation (SD) of three replicates. The data was subjected to one-way analysis of variance (ANOVA) and differences between samples were determined by Tukey multiple comparison test using the SPSS 16.0 (Statistical Program for Social Sciences) program. The level of significance was set at p<0.001.

**Results**

Findings of the present investigations are summarized in Table 1. There were no adverse effects of MO on the animals at the given dose levels. (200 and 400 mg/kg body weight/day for 14 days respectively). The hydro-ethanolic extract of *Moringa oleifera* pods was found to be non-toxic up to dose of 900 mg/kg body weight. The renoprotective effect offered by 400 mg/kg body weight was found to be greater than that of that of 200 mg/kg body weight. BHA was used as a positive control in the present study. Table 1 illustrates effect of hydro-ethanolic extract of *Moringa oleifera* pods and BHA on lipid peroxidation, activity of antioxidant enzymes (SOD and CAT) in control and treated groups against DMBA induced nephrotoxicity in mice.

**Table1: Effect of hydro-alcoholic extract of the pods of Moringa oleifera on lipid peroxidation and antioxidant enzymes against DMBA-induced nephrotoxicity in mice.**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Treatments (mg/kg)</th>
<th>LPO (μM/mg protein)</th>
<th>CAT (nmol/min/ml)</th>
<th>SOD (U/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>-</td>
<td>82.28±1.07*</td>
<td>8.24±0.023*</td>
<td>7.36±0.017</td>
</tr>
<tr>
<td>DMBA</td>
<td>15</td>
<td>101.80±1.27*</td>
<td>5.07±0.030**</td>
<td>5.95±0.012</td>
</tr>
<tr>
<td>MO</td>
<td>200</td>
<td>71.44±0.96*</td>
<td>9.15±0.015**</td>
<td>8.51±0.004</td>
</tr>
<tr>
<td></td>
<td>400</td>
<td>63.73±0.90*</td>
<td>9.52±0.016**</td>
<td>8.58±0.006</td>
</tr>
<tr>
<td>BHA</td>
<td>0.5%</td>
<td>60.44±0.87*</td>
<td>8.12±0.021**</td>
<td>8.11±0.008</td>
</tr>
<tr>
<td>MO+DMBA</td>
<td>200 + 15</td>
<td>86.66±1.12*</td>
<td>11.16±0.036</td>
<td>6.68±0.014</td>
</tr>
<tr>
<td>MO + DMBA</td>
<td>400 + 15</td>
<td>85.01±1.10*</td>
<td>8.17±0.014*</td>
<td>6.95±0.014</td>
</tr>
<tr>
<td>BHA+ DMBA</td>
<td>0.5% + 15</td>
<td>84.32±1.10*</td>
<td>7.73±0.036**</td>
<td>6.54±0.015</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± SD (n=10)

*p<0.01, **p<0.01 vs. control group

*p<0.001, **p<0.01 vs. Treated (DMBA) group

DMBA at a dose of 15 mg/kg body weight caused significant (p<0.001) increase in the LPO level and significant (p<0.001) decrease in CAT and insignificant (p>0.01) decrease in SOD activity, in comparison to control group. Oral administration of hydro-ethanolic extract of *Moringa oleifera* in dose of 200 and 400 mg/kg body weight and BHA (0.5%) significantly (p<0.001) decreased LPO level and significantly (p<0.001 and p<0.01) increased the CAT activity and insignificant elevation in SOD activity as compared to
control group. In comparison to DMBA treated group, pre-administration of hydro-ethanolic extract of *Moringa oleifera* pods at low dose (200 mg/kg body weight), high dose (400 mg/kg body weight) and BHA (0.5%) significantly (p<0.001) decreased the LPO level and significantly (p<0.001) enhanced the CAT activity. The SOD activity increased insignificantly (p>0.01) at low and high dose of MO and BHA, protecting kidney from renocellular damage due to DMBA. The renoprotective effect of the extract was comparable to the effect seen with BHA treatment.

Intake of hydro-ethanolic extract of *Moringa oleifera* at dose of 200 and 400 mg/kg body weight and BHA (0.5%) along with DMBA significantly (p<0.001) improved the LPO level and CAT activity while the administration of same dose insignificantly (p>0.01) elevated the SOD activity. Figure 1 shows the level of LPO in kidney of control and treated mice. Figure 2 and 3 depict the effect of *Moringa oleifera* extract and BHA on antioxidant marker enzymes (SOD and CAT) against DMBA induced nephrotoxicity in mice.

**Discussion**

Cancer chemoprevention involves the use of either natural or synthetic compounds to delay, inhibit or reverse the development of cancer in normal or pre-neoplastic conditions. Recent upsurge in identifying natural products of dietary origin associated with high degree of safety margins has been found to be beneficial as potent cancer chemopreventive agents (Bharali et al., 2003). Comprehensive reviews provide strong evidence that high intake of vegetables and fruits are associated with reduced cancer incidence (Block et al., 1992). It is known that balance between Phase I and Phase II enzymes can afford protection against numerous chemical carcinogens, and the induction of antioxidant enzyme facilitates their degradation from the body (Miller, 1998).

*Moringa oleifera* is believed to possess numerous medical properties and is being used for the treatment of ascites, rheumatism (Anwar et al., 2007), venomous bites (Mishra et al., 2009), enhancing cardiac function (Limaye et al., 1995), inflammation (Ezeamuzie et al., 1996); liver disease (Rao and Misra, 1998), cancer, hematological, hepatic, and renal function (Mazumder et al., 1999).

In the present study, we determined superoxide dismutase (SOD) and catalase (CAT) activities, as they are the key component of cellular defense system against oxidative stress. SOD converts superoxide (O2−) to hydrogen peroxide (H2O2) and is a major defense system for aerobic cells in combating the toxic effects of superoxide radical (Mishra et al., 2009). Catalase decomposes hydrogen peroxide (H2O2) into H2O and O2 and protects the tissue from highly reactive hydroxyl radicals. Lipid peroxidation, oxidative deterioration of lipid bilayer, has been measured as an index of production of excess ROS.

![Figure 1: DMBA induced changes in renal lipid peroxidation and their response to administration of hydro-ethanolic extract of *Moringa oleifera* in male mice.](image)

The toxicant induces a disturbance in the physiological state, which affects the enzyme activity. It then causes distortions in the cell organelles, which may lead to the elevation in the activity of various enzymes (Sharma et al., 2010). The DMBA toxicity...
stimulates the oxidative stress and the antioxidant enzymes are induced as a defense mechanism. It has been discovered that DMBA toxicity leads to free radical damage via two different pathways: (1) the production of reactive oxygen species (ROS), including hydroperoxides, singlet oxygen, and hydrogen peroxide, and (2) the direct reduction of antioxidant reserves (Sharma et al., 2010). The balance between the production of oxidants and the scavenging of those oxidants by antioxidants determines the extent of lipid peroxidation. In the present study, the activities of SOD and CAT antioxidants were reduced by DMBA, thus rendering the tissues to the peroxidative damage.

Superoxide dismutase plays an important role in catalyzing the dismutation of superoxide radicals. SOD enzymes work in conjunction with H$_2$O$_2$ removing enzymes, such as catalase and glutathione peroxidase. These antioxidant enzymes depend on various essential trace elements and prosthetic groups for proper molecular organization and enzymatic action. Increase in SOD activity should accelerate the removal of the reactive oxygen species. Catalase, whose activity has also been augmented by MO, helps in removing the hydrogen peroxide produced by the action of SOD, when compared with both doses of MO. Induced SOD activity along with that of catalase explains the decrease in lipid peroxidation, which is an indicator of oxidative stress that persists in the cell. The decreased lipid peroxidation in the present study is in correlation with the induction of antioxidant enzymes above basal level by the Moringa oleifera extract.

![Figure 2: Effect of administration of MO extract and BHA on antioxidant enzyme Catalase against DMBA-induced nephrotoxicity in mice.](image1)

![Figure 3: DMBA induced changes in renal SOD and their response to administration of hydro-ethanolic extract of Moringa oleifera in male mice.](image2)
Although the possible mechanism(s) of protection against DMBA induced nephrotoxicity was studied in the current study, it is possible that the protective effect of the extract is mediated through antioxidant and/or free radical scavenging activities. Literature has shown medicinal plants with nephroprotective properties to mediate their protection via antioxidant and/or free radical scavenging activities due to the high concentration of flavonoids and alkaloids they contain (Olagunju et al., 2009). The antioxidant property of Moringa may be due to the presence of phenolic compounds that was confirmed in this study by phytochemical screening of the extract. In this respect, Moringa pods contain important bioactive compounds including glucosinolates, isothiocyanates, thiocarbamates, and flavonoids (Bharali et al., 2003). These compounds quench ROS, chelate metal ions and regenerate membrane-bound antioxidants. This finding is consistent with previous studies, which demonstrated the antioxidant activity of Moringa extract (Kumar and Pari, 2003; Arabshahi et al., 2007).

β-carotene, the major component reported from the drumsticks of the plant (Bharali et al., 2003) and vitamin A and C present in Moringa oleifera serve as an explanation for their mode of action in the induction of antioxidant profiles in the present investigation, however, the exact mechanism is yet to be elucidated. The biochemical basis of the chemopreventive potency of Moringa oleifera extract may be attributed to the synergistic action of the constituents of the extract and the induction of Phase-II enzymes (GSTs) and antioxidant enzymes, which might be implicated in the anticarcinogenic activity.

The induction of enzymes by the Moringa oleifera extract represents a promising chemopreventive strategy as a bifunctional inducer, along with the enhancement of antioxidant system enzymes which affords protection against cellular damage and inhibits cancer promotion. Since most of the phytochemicals and micronutrients having chemopreventive properties occur in low concentration in vegetables and fruits, it may be possible that selective interactions among these dietary constituents will have a long lasting, potent and effective modality for cancer chemoprevention.

Conclusion

Summing these facts, it is plausible for the alkaloid, flavonoid and phenolic components of MO to be responsible for the observed biological effects. These could constitute areas of future research. Again, the nephroprotection offered by the extract could be due to the presence of the phyto-principles contained in it. Hence, it is proposed that the nephroprotective activities of the hydro ethanolic extract of pods of MO in DMBA-induced nephrotoxicity may involve its antioxidant and/or oxidative free radical scavenging activities. Any natural compound with anti-oxidant properties may help in maintaining health when continuously taken as components of dietary foods, spices or drugs. The increase in the levels of antioxidant profiles i.e. SOD and Catalase by Moringa oleifera drumstick extract may be attributed to have biological significance in eliminating reactive free radicals that may affect the normal functioning of cells. Also, the results of this study have confirmed the rationale for the folkloric use of the hydro-ethanolic pod extract of MO in the treatment of renal disorders.

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