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Antioxidant and hepatoprotective effect of *Urtica Dioica* extract against N-nitroso methyl urea induced injuries in mice

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The aim of this study is to investigate the antioxidant and protective effect of an aqueous extract from *Urtica dioica* on liver injuries, induced by one of the most potent dietary carcinogenic agents N- Nitroso methyl urea (NMU). Firstly, the free radical scavenging activity of *U. dioica* extract was assessed by measuring its capability to scavenge the radical 2,2-diphenyl-1-picrylhydrazyl (DPPH). Liver injury was induced in mice by intraperitoneal injection of NMU (50 mg/kg) while the aqueous extract of *U. dioica* was administered orally to the experimental animals. Haematoxylin/ Eosin based histology was performed to evaluate the histological changes in the liver. The result suggest that *U. dioica* extract contains high content of polyphenols and able to reduce DPPH radical. Furthermore, NMU treatment induces steatosis in mice liver, which is accompanied by inflammatory cell infiltration. Data show also that *U. dioica* extract can protect mice liver from NMU induced damage. These findings proved that *U. dioica* extract has an antioxidant activity and hepatoprotective effect against NMU induced injury.

Key words: N-nitrosomethylurea, *Urtica dioica*, antioxidant, liver.

INTRODUCTION

Cancer chemoprevention is defined as the use of natural, synthetic, biological or chemical agents to reverse, suppress, or prevent carcinogenic process and cancer progression (Saldanha and Tollefsbol, 2012). The success of several recent clinical trials in preventing cancer in high-risk populations suggests that chemoprevention is a rational and appealing strategy (Tsao et al., 2004).

Various dietary antioxidants have shown considerable promise as effective agents for cancer prevention by reducing oxidative stress which has been implicated in the development of many diseases (Khan et al., 2008). Moreover, many studies have focused on the chemoprotective properties of fruits, vegetables and plants (Cochrane et al., 2008; Desai et al., 2008; Svejda et al., 2010; Paul et al., 2013).

Animal cancer models provide an invaluable resource for the identification of tumor markers and the development of therapeutic interventions, as well as enabling the study of the carcinogenic process

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(Kelloff et al., 2005). Chemically induced tumors are of particular interest in terms of hosts–tumor interactions since they develop through carcinogenesis steps, developing as spontaneous arising cancer (Cekanova and Rathore, 2014). Among the most carcinogenic molecules used in animal models the nitroso compounds. These chemicals stimulate carcinogenesis in more than 40 animal species including higher primates and at a variety of sites and organs (Stuff et al., 2009).

N- Nitroso methyl urea (NMU) belongs to the N-nitroso group, it has been found in low quantities in our environment, our food and may also be formed from precursors in the human body (Mirvish, 1995, Shalini et al,. 2012). It is a very potent resorptive carcinogen which can induce tumor formation in several organs like stomach, liver, oesophagus and mammary gland (Talcott et al. 1990)

The present study was designed to investigate; firstly the antioxidant activity of an aqueous extract from *U. dioica*, a wild growing plant in East of Algeria. Its aerial parts are used in Algerian traditional medicine for prevention and treatment of diabetes, rheumatism, eczema, anaemia, hair loss and as an antidiarrheal **(**Boudjelal, 2013**).** Then, the protective effect of *U. dioica* extract was evaluated on liver histology of NMU carcinogenesis mice model.

MATERIALS AND METHODS

Aqueous extract preparation

U. dioica leaves were dried at room temperature and coarsely ground before extraction. The dried powdered sample (0.36 g) was macerated for 24 h with 100 ml of distilled water. The supernatant was filtered and sterilized using 22 µm Millipore filter. The final concentration of the extract was 3.6 mg/ml.

Total phenolic content

The amount of total phenolic was determined using the Folin-Ciocalteu method (Gutfinger, 1981), the reaction mixture was composed of 0.5 mL of plant extract, 5.0 mL of distilled water, and 0.5 mL of the Folin-Ciocalteu reagent and 1.0 mL of saturated sodium carbonate solution was added. This mixture was shaken and allowed to stand for 1 h. The absorbance was measured at 725 nm. A calibration curve of gallic acid was prepared, and the results were expressed as mg/gallic acid equivalents (GAE) / ml. Data were expressed as mean ±SD from at least three separate experiments

DPPH assay

The free radical scavenging activity of *U. dioica* extract was measured by 1,1-diphenyl-2-picryl-hydrazil (DPPH) using the method described by Söhretoglu et al. (2012). Briefly 0.1 mM solution of DPPH in methanol was prepared; 1 ml of the solution was added to 3 ml of the extract at different concentrations (0.72, 1.44, 2.16, 2.88 and 3.6 mg/ml). The mixture was shaken vigorously and allowed to stand at room temperature for 30 min. Then the absorbance was measured at 517 nm. Lower absorbance of the reaction mixture indicated higher free radical scavenging activity. The percent DPPH scavenging effect was calculated using the following equation:

DPPH scavenging effect (%) = [(A0-A1)/A0] × 100

Where A0 was the absorbance of the control reaction and A1 was the absorbance in the presence of the standard sample or extract.

The IC_{50} value represented the concentration of the sample leading to 50% reduction in the initial DPPH concentration. Data were expressed as mean ±SD from at least three separate experiments

Experimental animals

Females *Mus musculs* mice (18-22 g) procured from Pasteur institute Algiers were housed in plastic cages at room temperature (22±1°C) under a 12 h light/dark cycle and provided with rodent chow and water. The animal studies were conducted after obtaining clearance from Institutional Animal Ethics Committee.

Experimental design

The mice were divided into four groups with 8 animals in each group and were given a dose regimen as given as follows:

Group I: Control animals were given normal saline solution (0,9%).
Group II: Animals received weekly a single dose of 50 mg/kg NMU diluted in 0,9% saline solution, then administrated intra peritoneally.
Group III: Animals received daily oral dose of 75 mg/kg of *U. dioica*.
Group IV: Animals received every week a single dose of NMU (50 mg/kg, diluted in 0.9% saline solution) administrated intra peritoneally. The treatment by NMU, in the two groups (II and IV), lasted for 3 consecutive weeks.

One day after the last injection of NMU, animals of the third group received daily dose of 75 mg/kg of *U. dioica* through oral gavage.

The treatment with the *U. dioica* extract, in the last two groups, was lasted for 15 and 30 consecutive days after NMU injection.

Histopathological studies

Liver tissue for histopathological analysis was fixed in 10% buffered formalin saline, processed by routine histology procedure and embedded in paraffin. Tissues sections were then stained with Hematoxylin/eosin and observed under light microscope OPTECH OPTICAL TECNOLOGY®.

All reagents were purchased from Sigma Aldrich, Algeria.

RESULTS

Total phenolic content

Total phenolic compounds, as determined by Folin Ciocalteu method, are reported as gallic acid equivalents (GAE) by reference to a standard curve ($y = 0.0091x + 0.0378$, $r^2 = 0.99$). Total phenolic content was in the range of 109.4 ± 2.05 GAE /ml which is the equivalent of 302.96 ± 5.70 GAE/g of dried powder (Table 1).

Table 1. Total phenolic content (as GAE/ml) and scavenging activity of DPPH (µg/m) in *U. dioica* extract.

Parameter	Total polyphenols (GAE/ml)	IC50 value (µg/ml)
Urtica dioica aqueous extract	109.4 ± 2.05	8.73 ±0.96
Ascorbic acid	-	6.13 ± 0.79

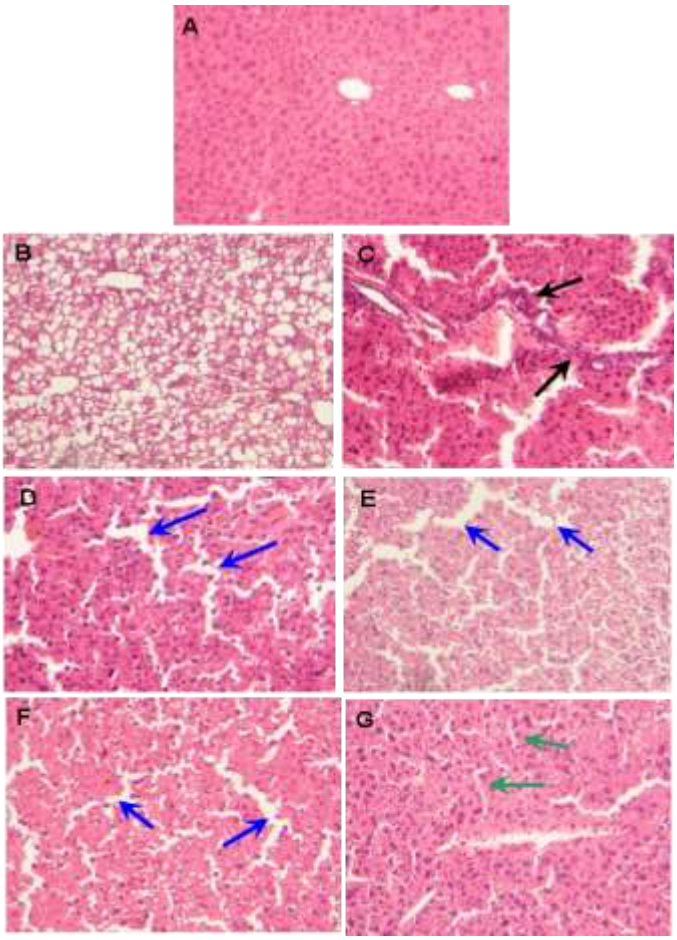

Plate 1. Photomicrographs of Hematoxylin and eosin stained sections of mice liver from different experimental groups (X100 magnification). Control group (A). Group 2, mice treated by intraperitoneal injection of NMU after 15 (B) and 30 (C) days. Group 3, mice treated by *U. dioica* extract after 15 (D) and 30 (E) days. Group 4, mice primed by NMU followed by *U. dioica* extract after 15(F) and 30 (G) days.

DPPH scavenging activity

The DPPH radical scavenging activity of *U. dioica* extract was increased by increasing the concentration of the sample extract. DPPH radical was scavenged by antioxidants through the donation of hydrogen, forming the reduced DPPH-H•. The color changes from purple to yellow after reduction, which can be quantified by its decrease of absorbance at wavelength 517 nm. The IC50 value (Table 1) of the extract was 8.73 ±0.96 µg/ml as opposed to that of ascorbic acid (IC50 = 6.13 ± 0.79 µg/ml), a well-known antioxidant. Thus, the extract has a comparative antioxidant capacity to ascorbic acid.

Effect on liver histology

Plate 1 shows micrographs of the liver tissues from control and experimental animals. The liver section from the control group shows normal hepatocytes with preserved cytoplasm and central portal vein (Plate 1A). After 15 days, the tissue sections from NMU treated group show extensive fatty change with the apparition of steatosis (Plate 1B). The macrosteatosis was the most predominant form. A marked inflammatory cell infiltration (shown by black arrows in plate 1C) was observed after 30 days.

Histopathological examination of liver sections from *U. dioica* extract shows sinusoidal dilatation (shown by blue arrows in Plate 1D and E). In liver sections of mice primed by NMU followed by *U. dioica* extract we notice normal hepatocytes with no vacuolated cytoplasm and also no area of infiltration by inflammatory cells. With this treatment sinusoidal dilation was observed only after 15 days (shown by blue arrows in Plate 1F), after that sinusoid return to their natural form (shown by green arrows in Plate 1G). These features gave an indication of the protective effect of the extract.

DISCUSSION

In the present study, we assessed the antioxidant activity and studied the effect of an aqueous extract from *U. dioica* on the liver of NMU primed mice

This study showed that the extract has an antioxidant activity that seemed due to the presence of phenolic compounds in *U. dioica* leaves. Polyphenols are known to have antioxidant properties due to their ability of scavenging free radicals and active oxygen species such as singlet oxygen, free radicals and hydroxyl radicals. Antioxidant activity of *U. dioica* has been also reported by Gulcin et al. (2004) and Guder and Korkmaz (2012).

Free radicals are highly reactive species, capable in the nucleus, and in the membranes of cells of damaging biologically relevant molecules such as DNA, proteins, carbohydrates, and lipids (Young and Woodside, 2001). They have been associated with the pathogenesis of disorder like cancer diabetes and cardiovascular diseases (Ratnam et al., 2006).

The harmful factor used in the study was the mutagen NMU. Environmental factors comprising tobacco smoke and various nitrostable foods like cured meats, beer, fish and cheese constitute the principal sources of this compound (Stuff et al., 2009). Liver is the major site of detoxification and the primary target of drug exposure, in the body different toxins such as pharmaceuticals, herbals, foods and supplements may lead to hepatic damage (Lopez and Hendrickson, 2014).

Our results demonstrate that macrosteatosis (Plate 1B) is the main form of liver injury induced by NMU. This form is potentially reversible and often associated with necrotic inflammation (Ikonen, 2006; Marques et al., 2010). This report is in accordance with our results, where the carcinogen induces inflammation after 30 days of treatment (Plate 1C). Different effects of NMU have been reported, it stimulated liver carcinogenesis, hyperplasia of the hepatic cells, congestion of the central vein and dilation of sinusoids (Wang et al., 1993).

According to our findings *U. dioica* leaf extract applied for 15 and 30 days (Plate 1D and C), can cause a little damage in liver that is presented here by a sinusoidal dilatation. Other side effects of *U.* dioica leaves, like cell infiltration and sinusoidal congestion have reported by Gunes et al. (1999).

On the other hand, the extract given after NMU can restore the damages induced by the carcinogen (Plate 1F and G) and inhibits the carcinogenic process in the liver. Several experimental studies have investigated the role of *U. dioica* in the prevention and therapy of liver disease. However, hepatoprotective effect of *U. dioica* has been reported against CCL4 induced injuries (Kanter et al., 2005; Kataki et al., 2012) and acetaminophen toxicity (Juma et al., 2015).

Conclusion

In conclusion, the present study revealed that *U. dioica* extract contains high quantity of polyphenols and can act as a free radical scavenger. The results also suggested that the plant exhibited hepatoprotective effect against liver injuries induced by the chemical carcinogen NMU.

Conflict of interests

The authors hereby declare that no conflict of interest exists among them.

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