Anti-ischemic Effect of German Chamomile (*Matricaria recutita* L.) Against Ischemia/reperfusion Induced Myocardial Damage in Isolated Rat Heart

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**Abstract:** Background: Chamomile is most popular consumed as a tea or tisanes. Traditionally this plant was used for treatment of many ailments such as cardiovascular diseases and inflammatory mediated diseases. We investigated the effects of anti-ischemic effect of *Matricaria recutita* L. against ischemia/reperfusion induced myocardial damage in isolated rat heart. **Materials and methods:** The protective effect of methanol extract of *Matricaria recutita* L. against Ischemia/Reperfusion induced myocardial damage (IRD) in isolated rat heart model. The hearts were excised and mounted on modified Langendorff setup and subjected to 15 min global no flow ischemia. Perfusates were collected both during pre and post-ischemia period. At the end of reperfusion, ischemic heart was either made into Heart Tissue Homogenate (HTH) or histological slides were prepared using haemotoxylin and eosin stains. The homogenate and perfusate was subjected for biochemical estimations. **Results:** The *Matricaria recutita* L. methanol extract showed dose-dependent cardioprotective activity by significant protection to myocardium from damage as indicated by significant elevated activities of endogenous antioxidant enzyme the Superoxide Dismutase (SOD) and Catalase (CAT), decrease in LDH and CK-MB activities in perfusate and vice versa in HTH. Similarly, the percentage recovery in developed tension and heart rate were significantly recovered in MR treated groups during post-ischemia as compared to control. These biochemical findings were supported by changes in histopathological studies. **Conclusion:** These results suggest that the methanol extract of *Matricaria recutita* showed potent anti-ischemic activity in ischemia/reperfusion induced myocardial damage in rat isolated heart.

**Key words:** Oxidative stress, chamomile, myocardial, cardioprotective, *Matricaria recutita*

**INTRODUCTION**

Oxidative stress defines that, the level of Reactive Oxygen Species (ROS) exists in excess of antioxidant defenses. This imbalance in the redox milieu results in a switch from ROS-stimulated ambient signaling processes to ROS-mediated pathophysiological consequences. Oxidative stress has been implicated in the installation and progression of several degenerative diseases via DNA mutation, protein oxidation and/or lipid peroxidation. In the vasculature, oxidant stress may result from either over production of ROS and/or a decrease in antioxidant capacity when either predominates in the vessel wall, the net result is ROS-mediated decrease in bioavailable nitric oxide and oxidative modification of lipids and proteins leading to impaired vasoconstriction reactivity, inflammation and dysregulated cell proliferation (Yung et al., 2006). Cardiac ischemia is a condition in which blood flow and oxygen supply are insufficient to the heart muscle. The main cause of cardiac ischemia is narrowed coronary arteries. When arteries are narrowed, there is less blood and oxygen supply to the heart muscles. Cardiac ischemia leads to coronary heart disease, angina pectoris, myocardial infarction, heart failure and ultimately heart attack (Kang et al., 2007).

Medicinal plants have been traditionally used in the treatment of several human diseases and their pharmacological and therapeutic properties have been attributed to different chemical constituents isolated from their crude extracts. Particularly chemical constituent of antioxidant activity can be found at high concentration in plants and can be responsible for their preventing effects in various degenerative diseases, including cancer, neurological and cardiovascular diseases. Thus, the antioxidant properties of plants have full range of perspective applications in human health care
(Pereira et al., 2008). *Matricaria recutita* L. (Asteraceae, commonly known as German chamomile) is one of the most widely used and well-documented medicinal plants in the world (Salamon, 1992). Chamomile is also exceptionally consumed as a tea or tonic. Chamomile is used both internally and externally to treat an extensive list of conditions. It is used externally for wounds, ulcers, eczema, gout, skin irritations, neuralgia, sciatica, rheumatic pain and hemorrhoids (Newall et al., 1996) and internally to treat anxiety, hysteria, nightmares, insomnia and other sleep problems, convulsions and even delirium tremens (Martens, 1995). The main chemical constituents of the German chamomile are terpenoids like α-bisabolol, chamazulene, sesquiterpenes and flavonoids like apigenin, luteolin and quercetin (Newall et al., 1996).

The purpose of the present study was to know the safe and potent cardioprotective effect of German chamomile against ischemia/reperfusion induced myocardial damage in Sprague-Dawley rats.

**MATERIALS AND METHODS**

**Chemicals and reagents:** Trichloroacetic acid (TCA), 2-Thiobarbituric Acid (TBA), 5,5′-dithiobis (2-nitrobenzoic acid), (±) epinephrine (Sigma-Aldrich Co. USA), 2, 3, 5- Triphenyltetrazolium Chloride (TTC) (Hi-media, Mumbai), CK-MB (Span diagnostics, India), LDH (Teco diagnostics, USA). All other chemicals, reagents and kits were procured are research grade. The instruments used are Refrigerator centrifuge (MPW-350 R, Korea), UV spectrophotometer (UV-1601, Shimadzu Corporation Kyoto, Japan), Mini Lysotrap (LTE Scientific Ltd.), Autoanalyser, Remi centrifuge (Remi industries, Mumbai), Homogenizer (Remi motors, Mumbai), Langendorff’s assembly and others.

**Plant materials and preparation of extract:** In the present study, capillitum of *Matricaria recutita* L. were collected from the National Botanical Research Institute (NBRI), Lucknow, India during the month of June 2009. Herbarium was prepared and the specimen was further identified and authenticated in Department of Botany, Basaveshwar Science College, Bagalkot, Karnataka. Voucher specimen (B.Sc./Bot./18/09) was deposited in the herbarium of the same college. All capillitum were dried at room temperature until they were free from moisture. Finally the capillitum were subjected to pulverizer to get coarse powder and then passed through sieve # 44 to get uniform powder. The sieved powder was stored in airight high density polyethylene container before extraction. The powdered capillitum (600 g) were subjected to successive extraction with petroleum ether (40-60°C) and subsequently with methanol (64-65.5°C). After the residue extraction, solvent was distilled off and excess solvent was completely removed by using a rotatory flash evaporator to get concentrated, then completely dried in freeze drier and stored in airtight container under refrigeration. The obtained extract (64 g, percentage yield 10.67%) and used for cardio protective activity.

**Phytochemical screening:** Phytochemical screening of the crude extract was carried out employing standard procedures and tests (Trease and Evans, 1978) to reveal the presence of chemical constituents such as terpenoids, flavonoids, tannins, coumarins among others.

**Animals:** The Sprague-Dawley rats of either sex (200-250 g) were obtained from the central animal house of H.S.K. College of Pharmacy and Research Centre, Bagalkot. The animals were housed at room temperature (25±1°C) with 50-55% relative humidity and given standard laboratory feed (Amruth agro industries, Sangali, Maharashtra) and water *ad libitum*. The study was conducted as per the Institutional Animal Ethical Committee (HSKCP/IACB, Clear/2007-08/1-8, dated 28/11/2007). In present study animals were randomized into 5 groups of 6 animals each and allowed to acclimatize for one week before the experiments.

**Experimental protocol for cardiac ischemia/reperfusion:** Cardio protective activity of methanol extract *Matricaria recutita* L. (MmR) in Ischemia/Reperfusion (I/R) induced injury in isolated rat heart preparation was carried out as per the described by Inamdar et al. (1994). The Sprague-Dawley rats were sub divided into five containing six animals in each groups.

- Effect of vehicle on normal control group
- Effects of vehicle on I/R induced injury in isolated heart
- Effect of 0.5 mg mL⁻¹ of MMR extract on I/R induced injury in isolated heart
- Effect of 1 mg mL⁻¹ of MMR extract on I/R induced injury in isolated heart
- Effect of 3 mg mL⁻¹ of MMR extract on I/R induced injury in isolated heart

**Induction of cardiac ischemia/reperfusion:** A Langendorff apparatus for the isolated perfused heart was set up as mentioned elsewhere. The heart was isolated from each animal under Ketamine hydrochloride (45 mg kg⁻¹) and Xylazine (10 mg kg⁻¹, i.p.) anesthesia.
The isolated heart was perfused with Kreb-Henseleit (K-H) solution gassed with Carbogen (95% O₂ and 5% CO₂) at 37°C at a constant flow rate of 5 mL min⁻¹. The composition of K-H solution was (mM) NaCl 118, KCl 4.7, NaHCO₃ 25, NaHPO₄ 1.0, MgSO₄ 0.57, CaCl₂ 2.5 and Glucose 11. The pH of K-H solution was adjusted to 7.4 to avoid K-H buffer acidosi that may occur after prolonged gassing with carbogen. The heart was allowed to equilibrate for 10 min and then normal heart amplitudes were recorded. Measurement of contractile force was done using force displacement transducer and recorded on a student Physiograph (INCO, Mumbai, India). After the initial pre-ischemic perfusion, heart was subjected to 15 min to induce global ischemia (Moudhedine et al., 1993), by blocking the flow of K-H solution and carbogen supply followed by 15 min of reperfusion. During this period of ischemia condition was started, MMR was dissolved in KH buffer, centrifuged for 15,000 rpm for 10 min, transferred the supernatant to another tube and filtered through a 0.2 μm syringe filter and the resultant MMR solution injected into the aortic line for 5 min to observe the effects of MR on a ischemia-induced heart with 65 mmHg perfusion pressure. In the control group equal volumes of KH buffer were injected into the aortic line for 5 min (Kang et al., 2007). The heart rate and developed tension were measured during pre-ischemic and post-ischemic period and percentage recovery was calculated. Volume Fraction of Intersitial Space (VFITS) in myocardial tissue was determined from haematoxylin and eosin (H and E) stained transverse section by using the following equation (Syed and Mohammed, 2008):

\[ \text{VFITS} = \frac{100\% \times \text{Area of interstitial space}}{\text{Total tissue area}} \]

Preparation of post-mitochondrial supernatant:
Following decapitation, the heart was removed and washed in cooled 0.9% saline, kept on ice and subsequently blot on filter paper, then weighed and homogenized as 10% (w/v) in cold phosphate buffer (0.05 M, pH 7.4). The homogenates were centrifuged at 1000×g for 10 min at 4°C (MPW-550R, Korea) and Post-Mitochondrial Supernatant (PMS) was kept on ice until assayed.

Biochemical estimation
Lipid peroxidation (LPO): Thiobarbituric Acid Reactive Substances (TBARS) in the homogenate were estimated by using standard protocol (Prabhakar et al., 2006). Briefly, the 0.5 mL of 10% homogenate was incubated with 15% TCA, 0.375% TBA and 5 N HCl at 95°C for 15 min, the mixture was cooled, centrifuged and absorbance of the supernatant measured at 512 nm against appropriate blank. The amount of lipid peroxidation was determined by using \( \epsilon = 1.56 \times 10^5 \text{M}^{-1} \text{cm}^{-1} \) and expressed as TBARS nmole mg⁻¹ of protein (Braughler et al., 1987).

Superoxide dismutase (SOD): Superoxide dismutase activity was determined based on the ability of SOD to inhibit the auto-oxidation of epinephrine to adrenochrome at alkaline pH (Misra and Fridovich, 1972). Briefly, 25 μL of the supernatant obtained from the centrifuged heart homogenate was added to a mixture of 0.1 mM epinephrine in carbonate buffer (pH 10.2) in a total volume of 1 mL and the formation of adrenochrome was measured at 295 nm. The SOD activity (U mg⁻¹ of protein) was calculated by using the standard plot.

Catalase (CAT): CAT activity was assayed by the method of Clairborne (1985). Briefly, the assay mixture consisted of 1.95 mL phosphate buffer (0.05 M, pH 7.0), 1.0 mL hydrogen peroxide (0.019 M) and 0.05 mL homogenate (10%, w/v) in a total volume of 3.0 mL. Changes in absorbance were recorded at 240 nm. Catalase activity was calculated in terms of nM H₂O₂ consumed min⁻¹ mg⁻¹ protein.

Total thiols: This assay is based on the principle of formation of relatively stable yellow colour by sulphhydryl groups with DTNB (Moron et al., 1979). Briefly, 0.2 mL of heart homogenate was mixed with phosphate buffer (pH 8), 40 μL of 10 m MDTNB and 3.16 mL of methanol. This mixture was incubated for 10 min and the absorbance was measured at 412 nm against appropriate blanks. The total thiol content was calculated by using \( \epsilon = 13.6 \times 10^3 \text{M}^{-1} \text{cm}^{-1} \) (Sedlak and Lindsay, 1968).

Glutathione (GSH): GSH was estimated in various tissues by the method of Sedlak and Lindsay (1968). Briefly, 5% tissue homogenate was prepared in 20 mM EDTA, pH 4.7, and 100 μL of the homogenate or pure GSH was added to 0.2 M Tris-EDTA buffer (1.0 mL, pH 8.2) and 20 mM EDTA, pH 4.7 (0.9 mL) followed by 20 μL of Ellman’s reagent (10 mM L⁻¹ DTNB in methanol). After 30 min of incubation at room temperature, absorbance was read at 412 nm. Samples were centrifuged before the absorbance of the supernatants was measured (Khynniam and Prasad, 2003).

Protein: Protein concentration in all samples was determined by the method of Lowry et al. (1951).

Measurement of infarction area: The infarction area was measured by 2, 3, 5-Triphenyltetrazolium Chloride (TTC) staining method according to Bederson et al. (1986). Following ischemia or reperfusion after varied durations
of ischemia, animals were decapitated and the hearts were removed. After the hearts were placed briefly in cold saline, four coronal heart slices (2 mm thick) were made. Then the slices were incubated in phosphate buffered saline (pH 7.4) containing 2% 2, 3, 5-Triphenyltetrazolium Chloride (TTC) at 37°C for 10 min and then kept in neutral-buffered formalin overnight. The images of the TTC-stained sections were acquired by scanning with a high resolution scanner (Hewlett-Packard Scanjet 6100C/T). Then the myocardial infarction area was observed and compared between various treatment groups and negative control group.

**Histopathology:** The heart from control and experimental groups were fixed with 10% formalin and embedded in paraffin wax and cut into longitudinal section of 5 μ thickness. The sections were stained with haemotoxylin and eosin dye for histopathological observation.

**RESULTS**

**Biochemical estimation:** The results showed in Table 1, revealed potential cardio protective activity of MMR. The present study demonstrates that, enhancement of SOD (p<0.01) activity and improvement in CAT (p<0.01) levels in MMR administered groups, which significantly showed the cardio protective effects of MEMR may be by virtue of its antioxidant properties.

The biological activities of endogenous enzymes like LDH and CK-MB were evaluated in coronary effluent (perfusate) during pre and post-ischemic period as well as in Heart Tissue Homogenate (HTH). During post-ischemia, there was significant decline in enzyme activities in LDH (p<0.001) and CH-MB (p<0.01) perfusate of MMR treated groups when compared to control group. Furthermore, there was significant elevation in activities in LDH (p<0.01) and CK-MB (p<0.001) HTH when compared to control groups.

As shown in Table 2, MMR significantly imparts recovery to ischemic heart in terms of developed tension (p<0.01) and heart rate (p<0.001). I/R induced elevation in VFITS values and histopathological scores. They showed patchy areas of necrosis, hyalinization of muscle fibers with focal cellular infiltrations. These damages were reversed significantly (p<0.01) in microscopic section of myocardial slides of MMR treated groups.

**Myocardial infarction area:** The myocardial infarction area revealed significant decrease in German chamomile treated groups as compared to negative control group (Fig. 1).

**Histopathology:** As shown in Fig. 2, in group II (negative control), ischemia caused marked intense inter fibrillar necrosis, vacuolization, macrovesicular fatty changes and damage and irregular arrangement and morphological change of myofibrils associated with increased inter fibrillar distance (Fig 2b). MMR exhibited significant cardiac remodeling activity against I/R induced injury in isolated rat heart preparation by normal cardiac architecture, arrangement of myofibrils and absence of inter fibrillar necrosis (Fig 2c-e).

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**Table 1:** Effect of the MR extract on biochemical estimation from heart tissue homogenate and perfusate in I/R induced injury in isolated rat heart preparation

<table>
<thead>
<tr>
<th>Groups</th>
<th>Biochemical estimations from heart tissue homogenate</th>
<th>Biochemical estimations from perfusate</th>
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<tbody>
<tr>
<td></td>
<td>SOD (µg/mg of protein)</td>
<td>CAT (µg/mg of protein)</td>
</tr>
<tr>
<td>Normal</td>
<td>40.35±4.783</td>
<td>0.04±0.001</td>
</tr>
<tr>
<td>Control</td>
<td>9.04±3.487</td>
<td>0.00±0.001</td>
</tr>
<tr>
<td>MMR 0.5 mg mL⁻¹</td>
<td>27.25±3.417</td>
<td>0.09±0.008</td>
</tr>
<tr>
<td>MMR 1.0 mg mL⁻¹</td>
<td>31.4±5.513**</td>
<td>0.14±0.004**</td>
</tr>
<tr>
<td>MMR 3.0 mg mL⁻¹</td>
<td>27.4±1.156</td>
<td>0.01±0.004</td>
</tr>
</tbody>
</table>

All values are expressed as a Mean±SEM, n = 3, One Way Analysis of Variance (ANOVA) followed by multiple comparison Dunn’s test. The minimum value of p<0.05 was considered as significant. *p<0.05, **p<0.01, ***p<0.001 as comparison to control group. SOD: Superoxide dismutase; CAT: Catalase; LDH: Lactate dehydrogenase; CK-MB: Creatine kinase-MB; MEMR: Menthael extract of *Matricaria recutita* L.

**Table 2:** Evaluation of the plant extract on percentage recovery of developed tension, heart rate and Volume fraction of Interstitial space (VFITS) and histological scores in I/R induced injury in isolated rat heart preparation

<table>
<thead>
<tr>
<th>Groups</th>
<th>Developed tension</th>
<th>Heart rate</th>
<th>VFITS (um)</th>
<th>Histological scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>53±1±5.88</td>
<td>75.9±8.5</td>
<td>30±0.2±1.9</td>
<td>3.0±0.3±0.0</td>
</tr>
<tr>
<td>MMR 0.5 mg mL⁻¹</td>
<td>64.8±12.70</td>
<td>85.36±6.47**</td>
<td>25±2.2±27</td>
<td>2.3±0.3±3.3</td>
</tr>
<tr>
<td>MMR 1.0 mg mL⁻¹</td>
<td>85.10±2.05*</td>
<td>91.9±0.98**</td>
<td>23±0.9±83</td>
<td>1.6±0.3±3.3</td>
</tr>
<tr>
<td>MMR 3.0 mg mL⁻¹</td>
<td>96.51±1.51**</td>
<td>95±0.70**</td>
<td>20.8±0.73**</td>
<td>1.3±0.3±3.3**</td>
</tr>
</tbody>
</table>

All values are expressed as a Mean±SEM, n = 3, One Way Analysis of Variance (ANOVA) followed by multiple comparison Dunn’s test. The minimum value of p<0.05 was considered as significant. *p<0.05, **p<0.01, ***p<0.001 as comparison to control group. MEMR: Menthael extract of *Matricaria recutita* L.
Fig. 1(a-e): Effect of the plant extract on myocardial necrosis study by TTC staining ischemia reperfusion (I/R) induced injury in isolated rat heart preparation. The effect of MEMR against I/R damage in rats evaluated by 2,3,5- Triphenyltetrazolium chloride (TTC) staining. a: normal, b: control group showed visible myocardial tissue was stained brick red as evident by the formation of red formazan with LDH of myocardial tissue. In control groups scattered patches of necrotic tissue were clearly visible as the unstained infarcted region. c, d, and e: 0.5, 1 and 3 mg mL$^{-1}$ of MEMR treated rat was showed markedly reduced infarction in myocardial tissue in heart. MEMR = Methanol extract of *M. recutita* L.

Fig. 2(a-e): Effect of the plant extract on histopathological observation in Ischemia/reperfusion (I/R) induced injury in isolated rat heart preparation The effect of MEMR against I/R induced damage in rats. Photographs of heart sections were prepared (6 μm thickness) from different treatment groups stained with Haematoxylin and Eosin, 40x. Plates: a: Normal group showed normal cardiac architecture and arrangement of myofibril, absence of interfibrillar necrosis, regular and normal multinuclear myofibrils arrangement and vacuolization, macrovesicular fatty changes. b: control group animals exhibited intense interfibrillar necrosis, vacuolization, macrovesicular fatty changes and damage and irregular arrangement and morphological change of myofibrils associated with increased interfibrillar distance. c, d, and E: 0.5, 1 and 3 mg mL$^{-1}$ of MEMR exhibited significant cardiac remodeling activity against I/R induced injury in isolated rat heart preparation by normal cardiac architecture, arrangement of myofibrils, and absence of interfibrillar necrosis. MEMR = Methanol extract of *M. recutita* L.
DISCUSSION

There is accumulating evidence, suggesting that disease conditions are directly or indirectly related to oxidative damage and they share a common mechanism of molecular and cellular damage. The present review focuses on the evidences concerning the involvement of free radicals in ischemia/reperfusion and their relationship to specific enzymatic levels (Lakshmi et al., 2009). In the present study, we estimated the enzymatic parameters (SOD and CAT) levels in the heart tissue as index to assess the severity of oxidative damage and subsequently protection by German chamomile and histopathological studies revealed the protection against I/R induced oxidative stress in German chamomile treated groups.

Ischemia is an acute or chronic form of cardiac disability arising due to the imbalance between the myocardial supply and demand for oxygenated blood. The IRI was induced following no-flow global ischemia (Syed and Mohammed, 2008) where sudden occlusion of Physiological Salt Solution (PSS) results in immediate biochemical alterations. The increase in intracellular Na⁺ serves to drive Ca²⁺ intracellularly via Na⁺/Ca²⁺ exchange that results in irreversible damage to myocardial apparatus at the end of 15 min global ischemia (Jennings et al., 1985). During ischemia, cellular ATP is degraded to form hypoxanthine and xanthine dehydrogenase is converted to xanthine oxidase. Xanthine oxidase uses oxygen and therefore, during ischemia, is unable to catalyze the conversion of hypoxanthine to xanthine, resulting in a buildup of excess tissue levels of hypoxanthine. When oxygen is re-supplied during reperfusion, conversion of the excess hypoxanthine by xanthine oxidase results into the formation of ROS. These ROS including superoxide anions (O₂⁻) hydroxyl radicals (OH⁻), hypochlorous acid (HOCI), hydrogen peroxide (H₂O₂) and peroxynitrite. These are the most potent and can cause damage to protein, lipid and nucleic acids, resulting in the inactivation of some enzyme activities, disruption of ion homeostasis and modification of the genetic apparatus and apoptotic death. The measurement of CAT activity was carried out as elevation in SOD but results in accumulation H₂O₂ which could further precipitate the MI (Yim et al., 1990). In addition to it, treatment with German chamomile was initiated with the evidence that the limitations of the in vitro studies, over in vivo regarding the cardioprotection by free radical scavengers in particular. Superoxide dismutase and catalase, the catalytic scavengers for superoxide anions or hydrogen peroxide, respectively modest protective effects had been observed. The significant reduced on enzymatic level of SOD and CAT in the myocardial of post-ischemia indicates the cellular damage. LDH and CK-MB isoenzyme are cytosolic enzymes and are sensitive markers of ischemia myocyte injury (Deodato et al., 1999). It is well established that the biological markers like endogenous enzyme are organ specific and leak from the damaged organ during necrosis (Hearse, 1979). The damaged to the cardiac musculature due to IRI results in leakage of cardiac biomarkers such as LDH and CK-MB into the perfusate with resultant decreased in their activities in Heart Tissue Homogenate (HTH) (Dumoulin et al., 2005). Increase in resting tension indicates injury to the heart, whereas, Increase in developed tension shows an improvement in cardiac contraction while a decreased in developed tension is an indication of injury to the heart. During global ischemia conditions, the isolated heart totally stops. Regaining of the heart beat after administration of the MMR in the post-ischemia state indicates that MMR methanolic extract possess positive chronotropic effect. The restoration of the heart beat by the Matricaria recutita L. is an indicative chronotropic effect.

Histopathological studies were carried out for conformation of biochemical findings. The parameters-VFITS and histological scores were used to determine the myocardial damage. Treatment with MMR substantially decreased the interstitial cavity and kept the myocardial integrity during IRI damage. This effect might be due to augmentation of endogenous antioxidant enzyme synthesis. There was also remarkable reduction in the pathological scores with German chamomile. Therefore, it is very likely that Matricaria recutita L. provides cardioprotection due to its antioxidant and anti-peroxidative properties. The results were further confirmed by histopathological and ultrastructural assessment. Natural products with such properties constitute an ideal choice for maximum therapeutic effect with minimal risk of latrogenic adverse effects. Present finding, suggests that German chamomile contain flavonoids like apigenin and phenolic compounds may be responsible for cardioprotective activity mediated through the inhibition of XO oxidase enzyme activity or by decreasing the calcium mobilization, this may leads to decreased glutamate levels or lipid membrane fluidity, reduces membrane potential and increased permeability to ions such as calcium.

Hence, cardioprotective activity of Chamomile may be due to presences of flavonoids and tannins. In conclusion, methanol extract of Matricaria recutita has anti-ischemic property against ischemia/reperfusion induced injury in rats. In addition, further studies are required to establish its mechanism of action.
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REFERENCES


