Biochemical effect of curcumin on experimentally induced myocardial injury in rats

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A B S T R A C T

Myocardial infarction (MI) is one of the main causes of death from cardiovascular disease. Curcumin was shown to exert potent antioxidant, anti-inflammatory, antiangiogenic, antimutagenic, anticoagulant and antidiabetic activities. This study was done to investigate the protective effects of curcumin in isoproterenol (ISO) induced myocardial injury in rats. Forty-eight rats were divided into 6 equal groups. Group I: (normal control) rats received no drugs. Group II :(curcumin) rats received curcumin (200 mg/kg b.wt/day) orally for 30 days. Group III: (acute myocardial infarction) rats injected ISO (20mg/kg b.wt /intraperitoneally) twice at the 29th and 30th days of experiment. Group IV: (chronic myocardial infarction) rats injected ISO (20mg/kg b.wt /intraperitoneally) twice at the 1st and 2nd days of experiment. Group V: (acute myocardial infarction + curcumin) rats received curcumin (200 mg/kg b.wt/day) for 30 days, then ISO was injected twice, at an interval of 24 hours, on the 29th and 30th days .Group VI: (chronic myocardial infarction + curcumin) rats injected ISO at the 1st and 2nd days of experiment and treated with curcumin for 30 days. Blood samples and heart tissue specimens were collected at the end of experimental period (30 days) for determination of serum Creatine kinase MB (CK-MB), Lactate dehydrogenase (LDH), cardiac Troponins (cTn) and Interleukin-1β (IL-1β). Moreover, heart tissues catalase (CAT), glutathione peroxidase (GP$_x$), reduced glutathione (GSH) and L-Malondialdhyde (L-MDA) were also determined. The obtained results showed a significant increase in serum cardiac marker enzymes (CK-MB and LDH) activities, cTn and IL-1β concentrations in addition to L-MDA in heart tissues of ISO-induced myocardial injury in rats. However, GPx and CAT activities and GSH concentration in heart tissues of myocardial infarction induced in rats were markedly decreased. Curcumin treatment was able to protect rat myocardium against isoproternol induced myocardial ischemic damage and the protective effect was attributed to its antioxidant properties by inhibiting free radical generation.

Keywords: *isoproterenol, curcumin, myocardial infarction, oxidative stress, cardiac marker enzymes.*

1. INTRODUCTION

Cardiovascular diseases (CVDs) such as hypertension and myocardial infarction (MI) are the most important causes of mortality in developing countries due to changing lifestyles (Rajadurai and Prince, 2007 b). Myocardial infarction (MI) is one of the main causes of death from cardiovascular disease. MI is defined as an acute condition of

necrosis of the myocardium that occurs as a result of imbalance between coronary blood supply and myocardial demand (Upaganlawar and Balaraman, 2010) and (Mudagal *et al.*, 2011). Ischemia is caused due to reduced blood supply to heart causes several biochemical alterations which may lead to cardiac dysfunction ultimately cell death. It is well recognized that free radicals generated in ischemic tissues causes metabolic stresses which results in degradation of tissue defense system, leading to myocardial damage and necrosis (Ojha *et al.*, 2011). Myocardial infarction increases the generation of reactive oxygen species in ischemic tissue, bringing about oxidative damage of membrane lipids, proteins, carbohydrates, DNA and brings changes in the mechanical, electrical, structural and biochemical properties of the heart (Wang *et al.,* 2009), thus a great deal of research is focused on the role of antioxidants in the prevention of many human diseases, particularly atherosclerosis, congestive heart failure and myocardial ischemia reperfusion injury (Patel *et al.,* 2010 and Tinkel *et al.,* 2012).

Isoproterenol is a synthetic adrenergic agonist that causes severe stress in the myocardium resulting in infarct like necrosis of the heart muscle (Upaganlawar *et al.*, 2011). Experimental and clinical studies on heart failure have shown that there is increased generation of reactive oxygen species such as super oxide anion (O⁻) and hydroxyl radical (OH⁻) which are involved in the formation of lipid peroxide, cell membrane damage, and destruction of antioxidative defense system (Rajadurai and Prince, 2007a). Since pathophysiological, biochemical, morphological functional alterations and histopathological lesions following isoproterenol administration in rats are similar to those in human MI, the ISP – induced MI serves as a well standardized model to study the beneficial effects and mechanism of many

drugs and the efficacy of various natural and synthetic cardio-protective agents (Mladenka *et al.,* 2009). Isoproterenol induced myocardial infarction (MI) in rats is accompanied with an increase in cardiac marker enzymes and lysosomal hydrolyses (Sathish *et al.,* 2003).

Curcumin is an orange yellow crystalline powder; a hydrophobic polyphenol derived from the rhizome of the herb *Curcuma longa* has a wide spectrum of biological and pharmacological activities. Chemically, curcumin is a bis-α, β-unsaturated β-diketone, which exhibits keto–enol tautomerism having a predominant keto form in acidic and neutral solutions and stable enol form in alkaline medium, practically insoluble in water and ether but soluble in ethanol, dimethylsulfoxide (DMSO) and acetone (Aggarwal *et al.*, 2003). Curcumin was demonstrated to have antioxidative (Lee *et al.*, 2009) and iron-chelating effects (Ishihara and Sakagami, 2005). It had anti-inflammatory (Kim *et al.*, 2008), antiangiogenic (Duvoix *et al.,* 2005), antimutagenic (Aggarwal *et al.*, 2003), anticoagulant and antidiabetic activities (Srinivasan and Menon, 2003). Additionally, Curcumin had antifungal, antiviral, antibacterial, antifibrotic, anti-venom, antiulcer, cardioprotective, hypotensive and hypocholesterolemic activities (Kurup and Barrios, 2008). Also, it had anti-HIV (Dickinson *et al.*, 2003), adaptogenic and anti-infectious (Srinivas *et al.,* 1992), and ant ischemic activities (Yadav *et al.*, 2009). The present study investigated the prospective protection and anti-inflammatory effect of curcumin against myocardial infarction induced by isoprotrenol in rats.

2. Materials and methods

2.1. Experimental animals:
Forty-eight male albino rats, 5-6 weeks old age and weighting about 150-200 g were used

in the experimental investigation of this study. Rats were obtained from the Laboratory Animal Research Center, Faculty of Veterinary Medicine, and Benha University. Animals were housed in separate metal cages; fresh and clean drinking water was supplied ad-libtium. Rats were kept at a constant environ-mental and nutritional condition throughout the period of experiment. The animals were left 14 days for adaptation before the beginning of the experiment.

2.2. Antioxidant agents and chemicals:

The antioxidant compounds and chemicals used in the present study were:

a. Curcumin

Curcumin (purity ~99%) is an orange yellow powder was manufactured by Fluka Co for chemicals and purchased from Elgoumhouria Co. for trading Chemicals Medicines and Medical Appliances, Egypt.

Preparation and dosage of Curcumin: Curcumin was dissolved in 7% DMSO (dimethylsulfoxide solution) (Aggrewal et al., 2003) and administered to rats orally at a dose level of (200 mg/kg b.wt) once daily for 30 days.

b. Isoproterenol

Isoproterenol hydrochloride: was purchased from Sigma chemicals Co. Isoproterenol was dissolved in normal saline and injected intraperitoneally (I.P.) at the dose level of (20mg/kg b.wt) twice at an interval of 24 hours.

Preparation of isoproterenol injection: Twenty mg of isoproterenol powder was dissolved in 1ml saline solution. The solution was injected intraperitoneally at a dose of 20mg/kg b.wt, twice for two consecutive days, at an interval of 24 hours for induction of myocardial infarction (Saravanan and Prakash, 2004).

2.3. Experimental design:

A total number of 48 rats were divided into six main equal groups, 8 rats each, as follow:

1) Group I: (normal control): Rats were administered 0.9% orally via intragastric intubation for 30 days.

2) Group II :(Curcumin): Rats received curcumin (200 mg/kg b.wt/day) orally for 30 days.

3) Group III: (Acute myocardial infarction): Rats injected isoproterenol hydrochloride (20mg/kg b.wt/i.p) twice at an interval of 24 hours on 29th and 30th days of experiment.

4) Group IV: (Chronic myocardial infarction): Rats injected isoproterenol hydrochloride (20mg/kg b.wt/i.p) twice at an interval of 24 hours on the 1st and 2nd days of experiment.

5) Group V:(Acute myocardial infarction + curcumin protected): Rats received curcumin (200 mg/kg b.wt/day) orally for 30 days and at the 29th and 30th days, then all rats were injected isoproterenol hydrochloride (20mg/kg b.wt/i.p) twice at an interval of 24 hours.

6) Group VI (Chronic myocardial infarction + curcumin treated): Rats injected isoproterenol hydrochloride (20mg/kg b.wt/i.p) twice at an interval of 24 hours at the 1st and 2nd days of experiment, then all rats were administered curcumin(200 mg/kg b.wt/day) orally for 30days.

2.4. Sampling:

Blood samples and cardiac tissue specimens were collected at the end of experiment after 30 days from all animal groups, At the end of experimental period, rats were anesthetized by (pentobarbital sodium 35mg/kg i.p) and the rats were sacrificed by cervical decapitation.

2.4.1. Blood samples:

Blood samples were collected from retero-orbital venous plexus of eyes in clean, dry screw capped tubes, the samples were allowed to coagulate at room temperature for 30 min, then centrifugated at 3000 r.p.m for 15 min. The clean clear serum was aspirated by pasture pipette and received in dry sterile sample tube, stored at-20ºc until used for subsequent biochemical analysis. All sera

were analyzed for the following parameters: Creatine kinase MB (CK-MB), Lactate dehydrogenase (LDH), Troponins (cTn) and Interleukin-B (IL-1B).

2.4.2. Tissue samples:

At the end of each experimental period, rats were sacrificed by cervical decapitation. The heart specimens were quickly removed, then perfused with cold saline to exclude the blood and blotted on filter paper and stored at-20 C until analysis. All heart tissues were used for determination of: Catalase (CAT), Glutathione peroxidase (GP$_x$), Reduced glutathione (GSH) and, L-Malondialdhyde (L-MDA).

Briefly, heart tissues were cut, weighed and minced into small pieces, homogenized with a glass homogenizer in 9 volumes of ice-cold 0.05 mM potassium phosphate buffer (pH 7.4) to make 10 % homogenates. The homogenates were centrifuged at 6000 r.p.m for 15 minutes at 4°C then the resultant supernatant was used for the determination of the following parameters: CAT, GPx and L-MDA. Also, 0.2 g of hear tissues were minced into small pieces homogenized with a glass homogenizer in 0.4 ml of 25% metaphosphoric acid (MPA) (ref. No.: 253-433-4, Sigma-Aldrich, Germany), then 1.4 mL of distilled water was added, mixed and incubated for 1 hour and centrifuged for 10 min at 3,000 r.p.m then the clean supernatant was removed and used for determination of GSH concentration.

2.5. Biochemical analysis:

Serum creatine kinase-MB and lactate dehydrogenase (LDH) activities were determined according to the method described by (Urdal and Lanndaa, 1979) and (Scientific Committee, 1982), respectively. Serum troponin concentration was determined by the method of (marieb, 2004) and (black, 2005) and serum Interleukin-1β level was determined using Rat IL-1 beta ELISA (Ray Biotech, IncCompany,Cat#:ELR-

IL1b)according to the manufacturer's instruction. Moreover, heart tissue Catalase (CAT), Glutathione peroxidase (GP$_x$), Reduced glutathione (GSH), and L-Malondialdhyde (L-MDA) were determined according to the methods described by Sinha, (1972), Gross et al., (1967), Moron et al., (1979) and Ohkawa et al., (1979), respectively.

2.6. Statistical analysis:

The results were expressed as mean ± SE using SPSS software program version 16 (SPSS© Inc., USA). The data were analyzed using one-way ANOVA to determine the statistical significance of differences among groups. Duncan's test was used for making a multiple comparison among the groups for testing the inter-grouping homogeneity. Values were considered statistically significant when p<0.05.

3. RESULTS

The data shown in table (1) illustrated that, serum Creatine kinase MB (CK-MB), Lactate dehydrogenase (LDH), Troponins (cTn) and Interleukin-B (IL1B) conc. were significantly elevated (P≤0.05) in rats received ISO alone when compared with the control group. Curcumin treatment to isoprotrenol injected rats significantly decreased the same parameters, prevented these changes, and resulting in a remarkable protection when compared with isoproterenol groups (acute and chronic groups).

The data summarized in table (2) revealed that, isoproterenol induced myocardial infarction in rats caused significant reduction in heart tissue CAT and GPx activities and GSH level with marked elevation in L-MDA concentration when compared to normal control group. However, in the groups that received ISO and curcumin, these cardiac antioxidant parameters (CAT, GPx, GSH) were significantly elevated and administration

of curcumin induce noticeable changes in ISO myocardial infarction rats causing a significant decrease in elevated heart tissue L-MDA in comparison with the ISO group.

Table1. Effect of curcumin administration on serum CK-MB and LDH activities, cTn and IL-1β concentrations in ISO-induced myocardial injury in rats.

Parameters Exp. groups	CK-MB (U/L)	LDH (U/L)	cTn (pg/ml)	IL-1β (pg/ml)
Normal control	57.22 [c]±4.61	367.44 [c]±21.90	11.95 ± 0.79[d]	214.04 [c]±19.81
Curcumin	99.60 [b]± 7.40	494.78 [b]± 6.27	51.23±1.65[b]	428.60 [b]±58.70
ISO (Acute)	188.6 [a]± 16.889	646.70 [b]± 27.319	68.58 [a]±2.83	622.20 [a]±10.30
protected (CUR +ISO)	90.80 [b]± 22.04	406.85[bc]± 40.8	25.91 [c]±2.76	383.91 [b]±45.93
ISO (chronic)	214.64 [a]± 13.269	810.93 [a]±35.94	103.86 [a]±3.78	768.70 [a]± 36.80
Treated (ISO+CUR)	95.97 [c]± 7.71	327.53 [c]±29.37	19.77 [c]±2.47	168.36 [b]±15.90

Data are presented as (Mean ± S.E).   S.E = Standard error.

Mean values with different superscript letters in the same column are significantly different at (P≤0.05).

Table 2. Effect of curcumin administration on heart tissue CAT and GPx activities, GSH and L-MDA concentrations in ISO-induced myocardial injury in rats.

Parameters Exp. groups	CAT (mmol/g. tissue)	GPx (ng/g. tissue)	GSH (ng/g. tissue)	L-MDA (mmol/g. tissue)
Normal	79.23 [a]± 6.60	0.80 [a]±0.11	7.30 [a]± 1.42	55.21 [b]± 6.85
Curcumin	40.54 [b]± 3.30	0.30[bc]± 0.03	3.1 [b]± 0.90	50.83 [b]± 4.70
ISO (Acute)	29.22 [b]±3.91	0.21 [c]± 0.04	2.81 [b]±0.65	131.81 [a]±16.96
protected (CUR +ISO)	72.63 [a]± 5.43	0.51 [c]± 0.04	7.31 [a]±0.70	54.55 [b]± 6.71
ISO (chronic)	36.24 [b]±3.80	0.23 [b]±0.05	3.21 [b]±1.21	135.05 [a]± 16.05
Treated (ISO+CUR)	73.50 [a]± 8.50	0.66 [a]±0.03	8.31 [a]±0.60	52.24 [b]±11.20

Data are presented as (Mean ± S.E).   S.E = Standard error.

Mean values with different superscript letters in the same column are significantly different at (P≤0.05).

4. DISCUSSION

Acute myocardial infarction (AMI) is commonly known as heart attack. It results from the interruption of blood supply to a part of the heart causing heart cells to die. The resulting ischemia (restriction in blood supply) and ensuing oxygen shortage, can cause damage or death (infarction) of myocardium if left untreated (Thygesen *et al.,* 2012).The present study evaluated the effects of curcumin treatment on myocardial infarction resulting from ISO injection. Injection of isoprotrenol (20 mg/kg b. wt., twice for two consecutive days at an interval of 24 hours) significantly elevated the serum activity of creatine kinase-MB (CK-MB) and lactate dehydrogenase (LDH) in addition to troponins (cTn) and interleukin-1β (IL-1β)

concentrations. This result agreed with (Sharmila and Rajadurai, 2012) who recorded significant increase in CK-MB and LDH activities in ISO injected rats. The cardiac marker enzymes may be due to the damage caused by ISO, the cardio toxic agent to the myocardial cells (Lalitha *et al.,* 2012). The activity of CK-MB is the most diagnostic for MI because of the marked abundance of this isoenzyme in myocardium and virtual absence from most other tissues and its consequent sensitivity (detection of necrosis of less than 100 mg of myocardium). The magnitude and persistence of elevation are useful in estimating the extent of infarction (Sobel, 1992). Heart damage induced by ISO was indicated by elevated levels of the marker enzyme such as CK-MB in serum as reported by (Ahmed *et al.,* 2004). Furthermore, cardiac enzymes were significantly increased in isoproterenol treated rats as reported by earlier studies (Farvin *et al.,* 2004), may be due to generation of free radicals released from damaged myocardial tissue (Balarraman *et al.*, 2007). Extent of cardio-protection offered by the drug is associated with significant attenuation of plasma creatine kinase (Gao *et al.*, 2000) and LDH activities (Hung *et al.*, 2000).

Administration of curcumin before and after isoproterenol injection (protective and treated group) reduced elevated serum CK-MB and LDH activities at the end of experimental period when compared to ISO group. This decrease may be due to the fact that, curcumin has established antioxidants and anti-inflammatory activities that offer promise in the treatment of cardiovascular diseases. For example, it can reduce creatine kinase (CK) and lactate dehydrogenase (LDH) activities Cheng *et al.* (2005), Dikshit *et al.* (1995), Nirmala and Puvanakrishnan (1996 b) and Yao *et al.* (2004). Likewise, Yousef *et al.,* (2008). Moreover, increase in the concentration of serum cardiac Troponin in

ISO injected rats may be due to the necrosis induced by ISO is mainly located in the subendocardial region of the left ventricle and the interventricular septum (Chappel *et al.* 1959). The mechanism of cardiac impairment caused by ISO is not clear and appears to be complex. Oxidative stress is probably one of the main causes (Tappia *et al.* 2001; Ojha *et al.* 2010). The positive inotropic and chronotropic effects of ISO at high doses lead to a depletion in the myocardial energy reserves, and thus result in biochemical and structural changes that may be responsible for the development of cardiac injury (MahammadRahmathulla and Kodidhela, 2013). Troponins represent a specific and sensitive tool for the assessment of cardiac damage.

Acute myocardial infarction (AMI) and heart failure (HF) are characterized by an intense inflammatory response that contributes to progression of the injury and dysfunction (Seropian *et al* .2014). Tissue injury stimulates the formation of the inflammation and the production of interleukin IL-1β (Toldo *et al*. 2015) and (VanTassell *et al*., 2013). Isoproterenol is a synthetic catecholamine that has positive inotropic and chronotropic effect. At therapeutic doses it increases cardiac output, however when administered in large doses it was reported to cause severe oxidative stress in the myocardium leading to necrosis of the left ventricular heart muscle (Alcantara *et al*.,2011). Increased concentrations of intracellular cAMP have been reported to inhibit the production of pro-inflammatory cytokines and the induction of enzymes that regulate inflammatory molecules (Zhang et al.,2004). IL-1β is the earliest cytokine-producing inflammatory reaction. Isoproterenol stimulated inflammatory factors (TNF-α, IL-1β) thereby extending significant cardio-protective effect against ISO induced

myocardial injury in rats (DeviSampath and Vijayaraghavan, 2007).

Curcumin is a highly pleiotropic molecule that interacts physically with its numerous targets. As a result, curcumin exerts its anti-inflammatory effects via several mechanisms, i.e., curcumin down regulates the nuclear factor-κB (NF-κB), resulting in a decrease in the expression of tumor necrotic factor- α (TNF-α), interleukin-1B (IL-1B) and interleukin-6 (IL-6) (Toldo et al. 2015). In the earlier study curcumin administration decreased TNF-α, IL-1β and IL-6 levels. TNF-α, and IL-6 are multifunctional cytokines produced primarily by activated monocytes and macrophages; they play a crucial role in the initiation and continuation of mucosal inflammation and immunity (Tracey and Cerami, 1994). These cytokines are involved in many cell processes including apoptotic cell death, metabolism, inflammation, thrombosis and fibrinolysis (Nilsen et $al.,$ 1998).

In the current study, injection of isoproterenol (20 mg/kg b. wt., twice for two consecutive days at an interval of 24 hours) significantly lowered the heart tissue CAT, GPx, GSH and significantly elevated L-MDA concentration. Higher levels of production of H_2O_2 lowered the activity of CAT (Stief, 2003). The activity of CAT was found to be significantly lower in ISO treated rats as compared with the control group, and after treatment with curcumin, CAT activity was found significant increase in heart tissue. ISO-caused oxidative stress in the heart as evidenced by lowered activities of myocardial catalase, which is consistent with an earlier study (StanelyMainzen, 2011). ISO-metabolism produce quinones, which react with oxygen to produce superoxide anions and hydrogen peroxides leading to oxidative stress and lowered endogenous antioxidant system (Rathore et $al.,$ 2000). Oxidative stress coexists with a reduction in antioxidant status (Sampath and Kannan, 2009). Treatment with

curcumin in ISO induced myocardial infarction in rats exhibited significant increase in the heart tissue CAT and GPx activities. These results were nearly similar to those recorded by (Popov et $al.,$ 2003) who reported that; curcumin normalized the antioxidant enzymes activities (CAT) of heart tissue. Curcumin has ability to scavenge free radicals, interacting with oxidative cascade, quenching oxygen, inhibiting oxidative enzymes and chelating metal ions and inhibits lipid peroxidation (Kamalakkannan et $al.,$ 2005).

Reduced glutathione GSH is an non-enzymatic antioxidants (free radical scavenger), preventing damage to important cellular components caused by reactive oxygen species such as free radicals and peroxides and is important substance in the cellular detoxication process, so the oxidation of GSH can also occur due to toxic metabolites, chemicals, and drugs (Pompella et $al.,$ 2003). Glutathione is involved in the destruction of hydrogen peroxide GSH dependent. Enzymes provide a second line of defense as they primarily detoxify the noxious byproducts generated by ROS and also help to prevent propagation of free radicals (Gumieniczek, 2005). GPx detoxify peroxides by reacting them with GSH. GST are detoxifying enzymes that catalyze the conversion of toxic products to fewer toxic products by conjugation with GSH. Low GPx activity in ISO- induced myocardial infarcted rats heart might be due to the low GSH content in the heart.

Since GSH is the substrate for GPx (Dominguez et $al.,$ 1998). The decreased availability of GSH is the reason for the lowered activity of GST observed in ISO - induced myocardial infarcted rats. The decreased GSH level in MI might be due to its increased utilization in protecting thiol groups containing proteins from the action of free radicals. Pretreatment with diosmin improved

the activity of GSH dependent enzymes and the concentration of GSH in the heart of ISO-induced myocardial infracted rats, by its antioxidant effect (SheelaSasikumar and ShyamalaDevi, 2000). Curcumin administration in ISO injected rats resulted in a significant increase in the heart tissue GSH concentration. The significant restoring of depleted GSH level in target organs with CUR treatment could be either due to its enhanced synthesis or improved glutathione reductase activity (Naik *et al.,* 2011), these CUR's antioxidant properties may be due to its ability to induce GSH-linked defense mechanisms against oxidative stress (Piper *et al.*, 1998) by protecting SH group of GSH and activating GST-α (Kunchandy and Rao, 1990).

A significant increase in heart tissue L-MDA was observed in ISO group when compared to the control group. this may be due to excessive formation of free radicals by auto-oxidation of ISO and activation of the lipid peroxidative process, resulting in an irreversible damage to the heart in animals subjected to ISO stress (Shaik *et al.*, 2012). The increased also might be due to free radical mediated membrane damage (Nagar, 2011). Malondialdhyde (MDA), a stable metabolite of the reactive oxygen species (ROS)-mediated lipid peroxidation cascade, was measured as previously reported (Sun *et al.,* 2005). During MI, the subsequent generation of lipid peroxides and lipid hydroperoxides results in the initiation of chain reactions that could damage the myocardium. The observed increase in these lipid peroxidation products indicates enhanced lipid peroxidation leading to myocardial injury and failure of the antioxidant defense mechanism to prevent the formation of excess free radicals. Treatment with curcumin in myocardial injury induced in rats resulted in a significant decrease in heart tissue L-MDA concentration at the end

of the experiment when compared with ISO - induced myocardial injury groups These results are in agreement with (Bonte, 1997) who reported that, treatment with curcumin and tetra hydro curcumin were protect the cells through attenuation of lipid peroxidation and decreased the production of free radical derivatives, as evident from the decreased levels of TBARS and hydro peroxides. Thus, curcumin and tetrahydrocurcumin offered protection against oxidative stress by scavenging of free radicals.

5. Conclusion

From the obtained results it could be concluded that, curcumin administration significantly curtails the effects of ISO induced myocardial infarction. This attenuation is verified by remarkable protection effect, decline cardiac enzymes (CK-MB and LDH) activity and cTn concentration, Powerful antioxidant, enhance the activity of CAT, GPx, increase GSH level and reduce(L-MDA) concentration with potent anti- inflammatory influence as it diminishes (IL-1B) production. These abilities of curcumin make it a potential drug for inhibiting myocardial infarction.

6. REFERENCES

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