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RESEARCH ARTICLE

Anti-Arrhythmic Potential of *Coriandrum sativum* Seeds in Salt Induced Arrhythmic Rats

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A B S T R A C T

In the present research, the anti-arrhythmic potential of *Coriandrum sativum* (seeds) was evaluated in $BaCl_2$ induced tachycardia and KCl induced bradycardia in rats. Heart rate and electrocardiogram (ECG) was recorded during the experimental period. The $BaCl_2$ increased the heart rate from 111/min to 157/min while KCL decreased the heart rate from 112/min to 60/min in the rats of positive control groups. ECG patterns also confirmed the tachy- and brady-arrhythmia in the rats of both positive control groups. The changes in biochemical cardiac biomarkers (CK-MB, LDH, AST, and ALT) were also the studied parameters. The level of cardiac biomarkers was significantly elevated in the serum of positive control rats as compared to their respective absolute controls. In case of both curative and preventive mode of treatment the elevated levels of enzymes, cardiac biomarkers were significantly reduced. Electrocardiogram (ECG) pattern revealed that the studied plant possesses a very good anti-arrhythmic potential in case of curative mode of treatment. The antiarrhythmic potential through preventive mode of treatment was also encouraging, but comparatively less than the curative mode of treatment. Anti-tachycardial potential of *C. sativum* was comparable with standard drug while, recovery in bradycardia was relatively slow than standard drug. Gross pathology and ECG pattern of base line group confirmed the innoxious nature of *C. sativum* seeds. Treatment of rats with *Coriandrum sativum* (100 $mgkg^{-1}$ BW) normalized the heart rate and attenuated the cardiac arrhythmia.

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INTRODUCTION

Cardiac arrhythmia is a medical problem associated with abnormal rhythm of the heart (Liu *et al*., 2009). In cardiac arrhythmia the heart rate may increases to an elevated level (tachycardia) (Wolkowicz *et al*., 2007) or decreases than normal rate (bradycardia) (Costa *et al*., 2002). It is generally because of dysfunctional ion channels leading to abnormalities in impulse generation or impulse conduction in cardiac muscles (Balijepalli and Kamp, 2008). Cardiac arrhythmia may be ventricular or supra ventricular, depending upon the cardiac tissue causing arrhythmia.

The squatness of breathing, weakness; dizziness, syncope (fainting) and chest pain are general symptoms of cardiac arrhythmia (Seferovic *et al*., 2006). The symptoms become more severe, when the heart rate is faster, the ventricular function is poor, or the arrhythmia is related with irregularities of autonomic tone (Bhatt *et al.*, 2005). Proper management and treatment of the arrhythmia can often normalize the function of the heart ventricles. So, it is imperative to manage arrhythmic disorders, as a large proportion of the population suffering in arrhythmias will be at high threat of sudden cardiac rest. Some synthetic drugs like beta blocker etc. are mostly used to treat cardio vascular related ailments like blood pressure and tachycardia, but these drugs have some side effects such as nausea, cramps in stomach, diarrhea, vomiting, depression, hallucination and gloominess (Anjum *et al*., 2014). Medicinal plants, being innoxious nature, indigenous and cheaper may be the better alternative for the treatment of cardiac arrhythmia (Hassan, 2012). Various medicinal plants have extraordinary potential to treat cardiac diseases with better efficacy and safety (Lokhande *et al*., 2006).

Coriander sativum L. also called as "cilantro" is an annual herbaceous plant of family Apiaceae, originally from the Mediterranean and Middle Eastern regions but cultivated worldwide due to its wide adaptation to variety of eco-geographic environments. The leaves and seeds of

this herb are widely used for culinary, aromatic and medicinal purposes. *Coriander sativum* possess various essential polyphenolic antioxidants that delay or slow down the oxidation progression by scavenging the free radicals generated in the cellular system (Rajeshwari and Andallu, 2011; Darughe *et al*., 2012; Nyakudya *et al*., 2014). In addition to antioxidant potential, the phytoconstituents of *C. sativum* seeds have antimicrobial, carminative and anticarcino-genic potentials but above all it also possesses ability to reduce cardiac diseases. The seeds of this plant possess great medicinal value. Therefore, the present research work was carried out to evaluate the anti-arrhythmic potential of *C. sativum* seeds in salt induced arrhythmic rats.

MATERIALS AND METHODS

Samples collection and extract preparation: *C. sativum* seeds were purchased from local market and got identified from plant taxonomist (voucher No. 227-4-2016), department of Botany, University of Agriculture, Faisalabad. Seeds were ground into fine powder and water extract was prepared.

Animals: Male albino rats of average weight between 200 to 250g were used for experimentation. Throughout the experiment, animals were placed under standard conditions of environment and food in Department of Clinical Medicine and Surgery, University of Agriculture, Faisalabad. Animals were kept according to the international ethical guideline under the supervision of veterinary doctor.

Experimental protocol: The effect of *C. sativum* seeds was evaluated in both preventive and curative mode of treatment. For this purpose, animals were divided into the following different experimental groups containing three rats in each group.

Absolute control groups: Rats were provided with pellets (combination of corn, wheat and grams) of rat diet for 16 days. **Positive control groups:** Rats were intoxicated with $BaCl_2$ and KCl (20mg.kg^{-1} BW) for four days to induce tachycardia and bradycardia, respectively. **Baseline group:** Rats were only treated with coriander seeds (300 mg kg^{-1} BW) orally for 16 days. **Standard drug group:** Rats were orally administrated with barium chloride and KCl (20 mg.kg^{-1}) for four days then these intoxicated rats were treated with standard drugs Inderal for tachycardia and Atropine for bradycardia for 12 days.

Curative treatment groups: $BaCl_2$ and KCl (20 mg.kg^{-1} BW) were orally administrated for four days to induce tachycardia and bradycardia respectively. After that these intoxicated rats were treated with coriander extract (300 mg kg^{-1} BW) for 12 days. **Preventive treatment groups:** Rats were pretreated with coriander seeds (300 mg.kg^{-1} BW) orally for 12 days and then intoxicated with $BaCl_2$ (20mg kg^{-1}) and KCl (20 mg.kg^{-1} BW) for 4 days to evaluate the anti-tachycardial and anti-bradycardial effect of *C. sativum* seeds.

Biochemical studies: Blood samples were collected without anticoagulant from different groups after an interval of 4 days, serum was separated and stored in freezer till further analysis. Different enzymes, cardiac biomarkers, such as lactate dehydrogenase (LDH), creatine kinase-MB fraction (CK-MB), aspartate transaminase (AST) and alanine transaminase (ALT) were analyzed using commercially available kits (Zafar *et al*., 2015).

ECG and heart rate of rats: ECG of rats was recorded by using Power Lab (ML856). In curative way of treatment ECG was recorded after four and sixteen days while, in preventive way of treatment ECG was recorded after the sixteen days.

Gross pathological studies: Immediately after killing animals humanely, their different body parts were removed and analyzed.

Statistical analysis: Each sample was analyzed in triplicate and data was expressed as mean±SEM. Data was analyzed using two way analysis of variance (ANOVA) in Mini Tab 17 software. Tukey Multiple Comparison test was used for comparison of means of different experiments (Jahan *et al*., 2012).

RESULTS

Anti-arrhythmic (anti-tachycardial and anti- bradycardial) potential of *C. sativum* seeds was evaluated through both curative and preventive mode of treatment in experimental rats.

Anti-tachycardial potential of *C. sativum*

Curative anti-tachycardial potential of *C. sativum* seeds on ECG pattern: Rats of absolute control group showed normal ECG pattern and heart rate (Fig. 1a, Table 1). In case of positive control, four days oral administration of $BaCl_2$ (20mg/kg BW) increased the heart rate significantly (157$\pm$1.02) as compared to absolute control group (114$\pm$1.0). The ECG of positive control group also showed that isoelectric interval between the end of 'T' wave and beginning of 'P' wave of ECG disappeared. Amplitude of P wave and QRS complex became increased but the amplitude and time interval of T wave was decreased. Furthermore, irregularity in base line and 'T' wave was also observed (Fig. 1b, Table 1).

The rats of curative group treated with *C. sativum* seeds for 12 days, showed almost normal heart rate (114$\pm$1.05 Table 1) and ECG pattern (Fig. 1c), indicating the anti-tachycardial potential of coriander seeds. In animals of standard drug group heart rate became normal after 12 days of treatment (Table 1), but missing 'QRS' complex and irregular fluctuation in base line of ECG at some places was observed (Fig. 1d).

Curative anti-tachycardial potential of *C. sativum* seeds on cardiac biomarkers: $BaCl_2$ significantly ($P<0.05$) increased the level of cardiac biomarkers (CK-MB, AST, ALT and LDH) in positive control group as compared to absolute control. When $BaCl_2$ intoxicated rats were treated with *C. sativum* seeds a significant decrease in the elevated level of cardiac enzymes was observed. The antitachycardial potential of *C. sativum* was comparable with standard synthetic drug (Table 2).

Table 1: Anti-arrhythmic potential of *C. sativum* seeds on electrocardiogram pattern through curative mode of treatment

Groups	Days of ECG	ECG interval and rate		P wave		QRS complex		T wave	
		Heart rate (BPM)	Interval (s)	Amplitude (mV)	Duration (s)	Amplitude (mV)	Duration (s)	Amplitude (mV)	Duration (s)
Absolute control	4th	111.8±0.70	0.536±0.003	0.066	0.03	0.527	0.02	0.168	0.046
	16th	111.2±0.75	0.529±0.015	0.067	0.03	0.528	0.02	0.165	0.046
Positive control group	4th	133.3±0.00	0.45±0.00	0.113	0.045	1.564	0.034	0.056	0.029
($BaCl_2$ induced tachycardia)	16th	157.9±0.00	0.38±0.00	0.049	0.014	0.876	0.011	0.093	0.022
Positive control group (KCl	4th	87.8±0.4	0.683±0.003	0.021	0.021	0.771	0.014	0.083	0.045
induced bradycardia)	16th	60.63±0.722	0.943±0.048	0.064	0.02	0.872	0.02	0.20	0.02
Curative group	4th	121.67±2.17	0.493±0.008	0.047	0.025	0.679	0.015	0.051	0.035
(tachycardia)	16th	114.53±0.67	0.516±0.008	0.048	0.02	0.791	0.038	0.042	0.048
Curative group	4th	93.2±0.96	0.643±0.006	0.122	0.026	1.474	0.016	0.283	0.06
(bradycardia)	16th	104.46±0.56	0.58±0.005	0.017	0.02	1.198	0.012	0.191	0.044
Standard drug group	4th	125.00±0.00	0.48±0.00	0.033	0.018	1.097	0.016	0.049	0.024
(Tachycardia)	16th	116.13±0.73	0.517±0.003	0.041	0.016	1.725	0.01	0.011	0.055
Standard drug group	4th	95.7±0.00	0.7±0.00	0.016	0.025	0.781	0.019	0.111	0.045
(bradycardia)	16th	112.5±0.700	0.53±0.003	0.067	0.02	0.926	0.048	0.236	0.044

BPM: Beats per minutes, s: second, mV: milivolt

Table 2: Curative anti-tachycardial effects of *C. sativum* seeds on cardiac markers

Cardiac enzymes	Days of sampling	Absolute control	Positive control	Curative group	Standard drug group
CK-MB (U/L)	1st	224.62±0.96^{c}	223.92±1.14^{e}	222.03±0.75^{e}	225.50±0.49^{d}
	4th	223.42±2.19^{d}	338.87±3.28^{a}	334.11±2.74^{a}	338.17±2.19^{a}
	8th	224.06±1.11^{e}	335.97±5.26^{b}	289.64±0.68^{b}	268.21±1.97^{b}
	12th	223.36±1.32^{e}	334.33±1.45^{c}	251.85±0.10^{c}	235.32±2.35^{c}
	16th	222.44±2.49^{e}	332.10±2.51^{d}	234.61±4.37^{d}	225.33±3.15^{e}
AST (U/L)	1st	73.29±2.11^{b}	69.96±1.08^{e}	71.92±5.19^{e}	70.77±2.88^{d}
	4th	69.21±4.56^{d}	149.83±2.39^{a}	150.70±1.65^{a}	148.08±1.92^{a}
	8th	71.40±1.24^{e}	146.20±0.33^{b}	91.83±3.98^{b}	94.73±7.25^{b}
	12th	69.14±1.31^{e}	145.58±1.72^{c}	82.61±1.92^{c}	79.40±1.28^{c}
	16th	70.15±2.51^{c}	144.28±3.12^{d}	76.34±2.74^{d}	68.35±7.31^{e}
ALT (U/L)	1st	25.08±0.35^{bc}	22.70±0.35^{e}	26.37±0.58^{e}	23.21±0.45^{e}
	4th	25.00±5.16^{bc}	87.11±0.48^{a}	88.13±4.23^{a}	89.68±1.23^{a}
	8th	25.12±0.91^{e}	85.76±2.18^{b}	65.81±1.43^{b}	58.13±0.61^{b}
	12th	24.85±1.36^{e}	84.10±4.51^{c}	48.04±0.54^{c}	42.32±3.12^{c}
	16th	25.19±2.43^{c}	83.34±4.11^{d}	33.37±1.45^{d}	28.00±0.21^{d}
LDH (U/L)	1st	171.30±2.13^{b}	171.87±1.02^{e}	173.30±2.38^{e}	171.58±4.29^{d}
	4th	172.04±0.33^{d}	378.09±0.92^{a}	378.04±3.11^{a}	374.06±0.38^{a}
	8th	176.43±3.13^{e}	376.37±1.74^{b}	260.67±0.12^{b}	223.73±1.09^{b}
	12th	175.15±0.14^{e}	374.83±0.99^{c}	235.56±1.21^{c}	182.06±3.51^{c}
	16th	173.43±4.02^{c}	371.51±1.32^{d}	195.93±7.34^{d}	169.52±2.53^{e}

Values (mean±SEM) with different superscript in a row differ significantly (P<0.05). AST=Aspartate transaminase; ALT=Alanine transaminase; CK-MB=Creatine kinase-MB; LDH=Lactate dehydrogenase.

Preventive anti-tachycardial potential of *C. sativum* seeds on ECG pattern: In rats of preventive group, pretreated with *C. sativum* for 12 days, after $BaCl_2$ administration, slow increase in heart rate was observed as compared to positive control (Fig. 1f, Table 3). Rats of absolute control group showed normal ECG pattern and heart rate (Fig. 1a, Table 1) as compared to positive control (Fig. 1b, Table 1). Rats of baseline group illustrated normal heart rate with little fluctuation in base line of ECG (Fig. 1e, Table 3).

Preventive anti-tachycardial potential of *C. sativum* seeds on cardiac biomarkers: In preventive mode of treatment, a significant (P<0.05) increase in the level of cardiac biomarkers (CK-MB, AST, ALT and LDH) was observed in animals of positive control group as compared to absolute control. However, after the administration of $BaCl_2$, very little increase in the level of cardiac biomarkers was noticed in *C. sativum* pretreated preventive rats as compared to negative control (Table 4). The level of these biomarkers remained normal in base line group.

Anti-bradycardial potential of *C. sativum*

Curative anti-bradycardial effect of *C. sativum* seeds on ECG pattern: During the evaluation of anti-bradycardial potential of *C. sativum*, low heart rate was observed in rats of positive control (60±0.722) as compared to absolute control group (111±0.75, Table 1, Fig. 2a). In positive control rats, treated with KCl for four days, amplitude and duration of P, QRS and T wave also became altered from normal pattern. At many places 'QRS' complex was missing, base line was fluctuating in an irregular fashion and 'P' wave was also arising irregularly (Fig. 2b). However, after treating the animals of curative group with *C. sativum* seeds normal heart rate was regained and ECG showed normal pattern (Fig. 2c, Table 1). Same trend with little fluctuations was observed in standard drug group (Fig. 2d, Table 1).

Curative anti-bradycardial potential of *C. sativum* seeds on cardiac biomarkers: KCl intoxicated rats showed significant increase in the level of cardiac biomarkers (CK-MB, AST, ALT and LDH) in positive control group as compared to absolute control group. In, groups of rats cured with *C. sativum* and standard drug through curative mode of treatment, the level of cardiac enzymes reached to normal after 12 day treatment. However, the anti-bradycardial activity of *C. sativum* was found to be slightly less efficient than that of the standard drug (Atropine), in comparison to the control (Table 5).

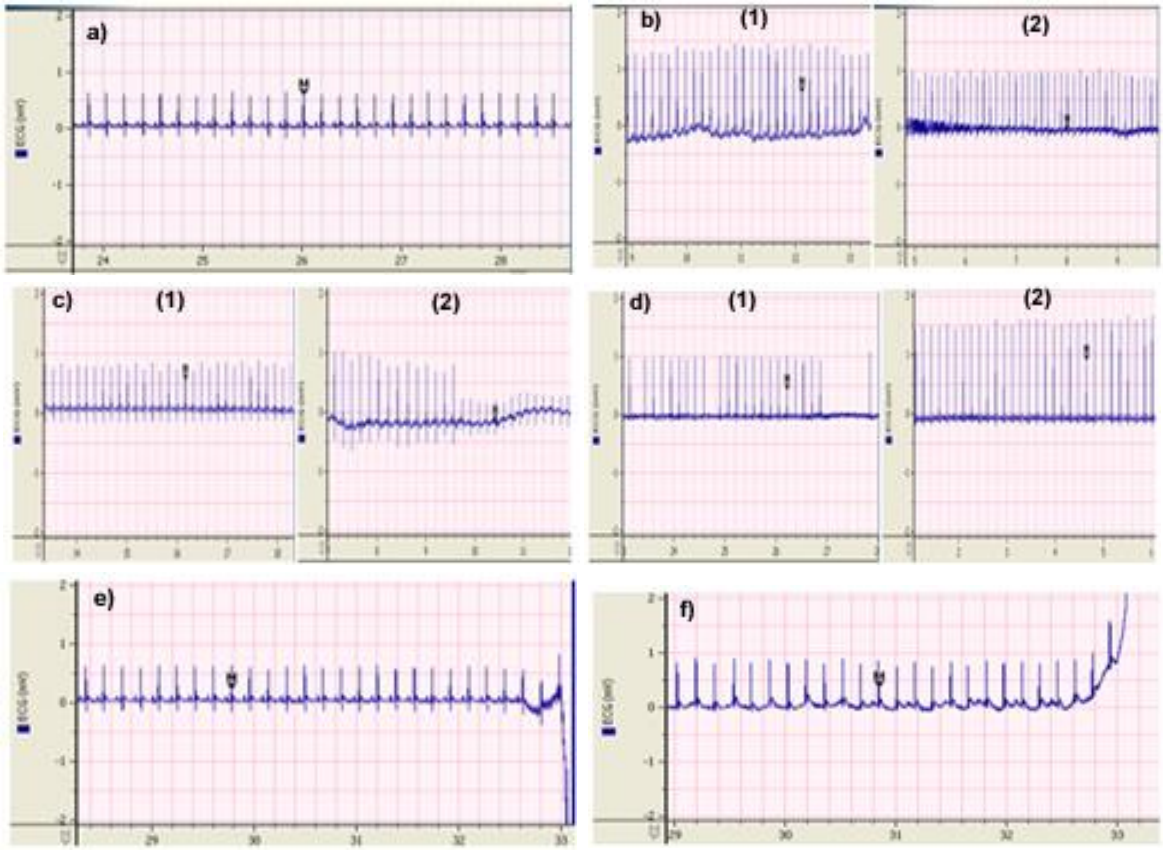

Fig. 1: ECG patterns of rats with tachy-arrhythmia induced by $BaCl_2$. Groups a) Absolute control, b) Positive control, c) Curative, d) Standard drug e) Baseline and f) Preventive.

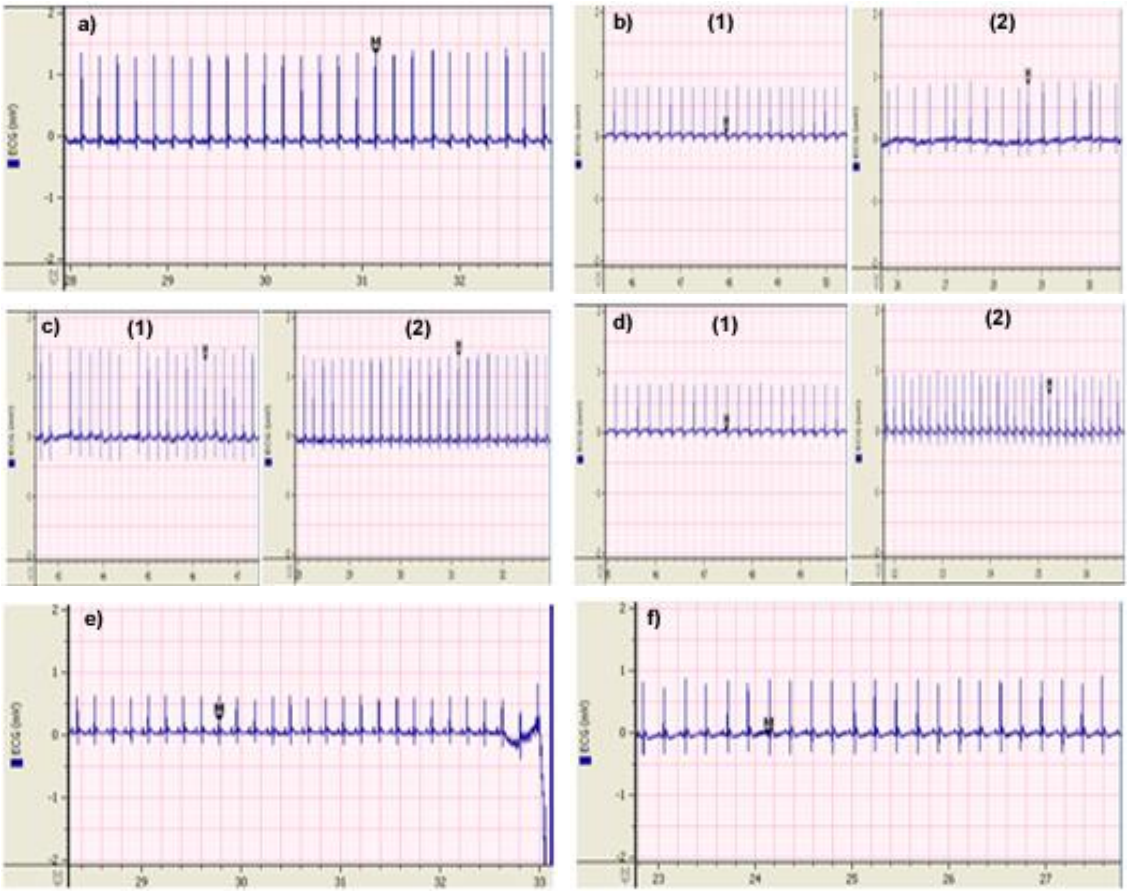

Fig. 2: ECG patterns of rats with brady-arrhythmia induced by KCl. Groups a) Absolute control, b) Positive control, c) Curative, d) Standard drug (e) Baseline and f) Preventive.

Table 3: Anti-arrhythmic potential of *C. sativum* seeds on electrocardiogram pattern through preventive mode of treatment

Groups	ECG interval and rate		P wave		QRS complex		T wave	
	Heart rate (BPM)	Interval (s)	Amplitude (mV)	Duration (s)	Amplitude (mV)	Duration (s)	Amplitude (mV)	Duration (s)
Absolute control	104.00±1.02	0.58±0.00	0.17	0.02	0.929	0.013	0.190	0.045
Base line group	112.5±0.700	0.533±0.003	0.074	0.02	0.543	0.016	0.072	0.035
Positive control group (tachy-arrhythmia)	157.9±0.00	0.38±0.00	0.049	0.014	0.876	0.011	0.093	0.022
Preventive group (tachy-arrhythmia)	125.2±0.133	0.486±0.003	0.053	0.02	0.817	0.016	0.154	0.042
Positive control group (brady-arrhythmia)	60.63±0.722	0.943±0.048	0.064	0.02	0.872	0.02	0.2	0.02
Preventive group (brady-arrhythmia)	93.3±0.500	0.643±0.003	0.064	0.02	0.763	0.034	0.147	0.038

BPM: Beats per minutes, s: second, mV: milivolt

Table 4: Preventive anti-tachycardial effect of *C. sativum* seeds on cardiac enzymes

Groups	CK-MB (U/L)	AST (U/L)	ALT (U/L)	LDH (U/L)
Absolute control	226.18±0.93^{c}	71.51±0.79^{d}	25.07±0.57^{d}	176.43±2.21^{c}
Positive control	337.25±1.38^{a}	145.58±1.72^{a}	84.54±43.21^{a}	374.83±0.99^{a}
Baseline group	225.11±2.67^{d}	72.64±1.18^{c}	26.22±0.18^{c}	174.12±4.38^{d}
Preventive group	281.11±0.67^{b}	82.13±2.41^{b}	67.29±1.32^{b}	245.03±6.57^{b}

Values (mean±SEM) with different superscript in column differ significantly (P<0.05). AST=Aspartate transaminase; ALT=Alanine transaminase; CK-MB=Creatine kinase-MB; LDH=Lactate dehydrogenase.

Table 5: Curative anti-bradycardial effect of *Coriandrum sativum* seeds on cardiac enzymes

Cardiac enzymes	No. of samples	Absolute control	Positive control	Curative	Standard drug
CK-MB (U/L)	1st	223.57±0.73^{e}	224.70±0.79^{e}	223.67±0.57^{e}	226.72±0.52^{d}
	4th	225.37±1.91^{d}	317.28±4.91^{a}	318.52±1.39^{a}	315.00±3.06^{a}
	8th	224.56±2.62^{e}	316.54±0.32^{b}	271.35±0.88^{b}	261.50±0.77^{b}
	12th	226.55±0.99^{b}	314.85±1.38^{c}	249.98±1.54^{c}	232.27±0.73^{c}
	16th	221.14±1.49^{e}	313.43±4.23^{d}	230.21±6.43^{d}	224.12±1.43^{e}
AST (U/L)	1st	68.07±1.28^{e}	70.62±1.08^{e}	71.33±2.11^{d}	70.16±3.41^{d}
	4th	70.29±0.34^{e}	132.56±7.54^{a}	124.00±2.54^{a}	124.83±0.77^{a}
	8th	69.03±5.15^{c}	127.45±3.51^{b}	86.24±4.71^{b}	92.30±0.41^{b}
	12th	71.52±0.13^{b}	126.95±2.71^{c}	75.38±0.77^{c}	81.72±5.12^{c}
	16th	70.10±2.91^{c}	123.42±4.61^{d}	69.89±3.81^{a}	70.31±2.55^{e}
ALT (U/L)	1st	25.11±0.51^{b}	24.38±0.31^{e}	27.80±0.25^{d}	25.78±0.42^{d}
	4th	24.23±0.43^{e}	77.14±1.13^{a}	75.48±0.77^{a}	76.72±3.35^{a}
	8th	24.77±0.38^{d}	76.70±1.23^{b}	62.60±1.07^{b}	56.50±0.30^{b}
	12th	25.23±3.16^{c}	73.64±1.45^{c}	45.06±3.14^{c}	44.55±5.83^{c}
	16th	23.19±3.21^{c}	72.84±3.52^{d}	25.33±4.12^{e}	25.44±0.86^{e}
LDH (U/L)	1st	174.46±1.1^{a}	169.27±2.10^{e}	171.40±4.56^{e}	173.24±0.77^{d}
	4th	175.22±0.41^{e}	269.03±0.01^{a}	268.08±1.61^{a}	257.26±5.42^{a}
	8th	177.98±0.55^{b}	263.00±2.53^{b}	257.80±0.67^{b}	225.14±0.41^{b}
	12th	175.51±1.52^{d}	256.34±2.12^{c}	238.06±0.54^{c}	189.66±1.09^{c}
	16th	176.13±3.02^{c}	255.29±2.18^{d}	191.84±6.44^{d}	171.02±1.36^{e}

Values (mean±SEM) with different superscript in a row differ significantly (P<0.05). AST=Aspartate transaminase; ALT=Alanine transaminase; CK-MB=Creatine kinase-MB; LDH=Lactate dehydrogenase.

Preventive Anti-bradycardial potential of *C. sativum* seeds on ECG pattern: Rats of positive control group showed abnormal ECG pattern and low heart rate (Fig. 1a, Table 1) as compared to absolute control (Fig. 1b, Table 1). However, in case of preventive group, after the administration of KCl, no significant change in heart rate and heart rhythm in ECG pattern was observed, as compared to positive control group (Fig. 2f, Table 3). The rats of baseline bradycardia group, showed normal heart rhythm (Table 3, Fig. 1e).

Preventive anti-bradycardial potential of *C. sativum* seeds on cardiac biomarkers: Rats of base line group showed normal level of cardiac enzymes (CK-MB, AST, ALT and LDH) after 12 days oral administration of coriander seeds. In case of preventive group of rats, no significant elevation in the level of these enzymes was observed as compared to absolute control due to prior treatment of animals with coriander seeds (Table 6).

Gross pathological examination: In the rats of positive control group ($BaCl_2$ induced tachycardia) heart was found damaged, harder and showed necrosis. Severe congestion and hemorrhages was observed in heart of the rats of positive control (KCl induced bradycardia) group. The rats of curative and preventive groups treated with *coriander sativum* showed almost normal appearance of various organs with significantly less congestion and damage in heart of rats as compared to the positive control groups. The heart, lung, liver and both kidneys were normal in the rats of both absolute control and base line groups.

DISCUSSION

The present study was designed to investigate the anti-arrhythmic potential of *C. sativum* seeds against $BaCl_2$ induced tachycardia and KCl induced bradycardia. *C. sativum* seeds showed anti-arrhythmic potential because of its substantial phytochemicals and polyphenolic contents including phenolic acids and flavonoids (Patel *et al*., 2012; Anfenan, 2014).

Coriander seeds significantly lowered the heart rate and maintained the heart rhythm in $BaCl_2$ induced tachycardial rats indicating its anti-tachycardial potential. Normally $BaCl_2$ induces cardiac arrhythmia by disturbing the electrolyte balance that is necessary for the proper functioning of heart. Another reason for $BaCl_2$ to induced tachycardia is that it declines the outward flow of K^+ from cell causing hypokalemia (Ammar *et al*., 2014).

Table 6: Preventive anti-bradycardial effect of *C. sativum* seeds on cardiac enzymes

Groups	CK-MB (U/L)	AST (U/L)	ALT (U/L)	LDH (U/L)
Absolute control	222.66±0.72^{d}	70.41±1.22^{d}	25.80±2.78^{c}	174.46±0.31^{d}
Positive control	319.15±1.38^{a}	125.43±2.11^{a}	85.39±3.42^{a}	368.34±2.12^{a}
Baseline group	225.60±1.65^{b}	72.49±2.54^{c}	24.43±0.30^{c}	175.48±6.42^{c}
Preventive group	285.53±0.38^{c}	85.47±6.12^{b}	58.39±2.11^{b}	251.03±0.60^{b}

Values (mean±SEM) with different superscript in column differ significantly (P<0.05). AST=Aspartate transaminase; ALT=Alanine transaminase; CK-MB=Creatine kinase-MB; LDH=Lactate dehydrogenase.

$BaCl_2$ also have adverse influence on atomicity of heart that causes ventricular tachycardia. It alters some of the parameters of electrocardiogram and results in the elevation of 'QT' interval and ventricle fibrillation. Due to oral administration of $BaCl_2$, isoelectric interval between the end of 'T' wave and beginning of 'P' wave disappears and causes atrial fluttering (January *et al*., 2014). Increased time interval of QRS complex cause blockage in bundle branches **(**Tahmaz *et al*., 2013**)**. In curative mode of treatment most of the abnormalities in electrocardiogram patterns were recovered. However, rats of preventive group showed small elevation in 'ST' segment (Fathiazad *et al.,* 2012).

Along with causing the arrhythmia, $BaCl_2$ also alters the electrical conductivity of heart and cause cell necrosis due to which Ca^{+2} level rises in blood stream resulting in increased cardiac enzymes (Subhashini *et al*., 2011). High dose of $BaCl_2$ (20mg/kg/BW) and KCl (20mg/kg/BW) have the ability to destruct the myocardium and cause cardiac toxicity. As a result of this myocardium injury cardiac enzymes (CK-MB, AST, ALT and LDH) secreted into the blood and serve as diagnostic markers of cardiac toxicity (Ojha *et al.,* 2011; Vijay *et al*., 2011).

Present results indicated that the oral administration of *C. sativum* seeds had a profound effect on the level of cardiac biomarkers in both curative and preventive modes of treatment. In curative treatment, arrhythmic rats were treated with *C. sativum* seeds at dose of 300mg/kg body weight for 12 days. This treatment significantly reduced the $BaCl_2$ and KCl induced secretion of cardiac enzymes (CK-MB, AST, ALT and LDH). In case of preventive treatment, the rats pre-treated with *C. sativum* seeds significantly restrained the elevated releases of these cardiac enzymes. The ingestion of high dose of KCl (20 $mgkg^{-1}$ BW) results in hyperkalemia, a condition in which concentration of K^+ is increased in the plasma. High dose of potassium chloride induces bradycardia by disquieting the concentration of K^+ inside the cell (Liu *el al*., 2013). ECG pattern of KCl intoxicated rats showed that oral administration of KCl decreased the heart rate and cause irregularity in 'P' wave, 'QRS' complex and T wave. Missing 'QRS' complex indicated second degree blockage in atrioventricular (AV) node. Normal ECG pattern of curative and preventive group showed the antibradycardial potential of *C. sativum* seeds. All these changes in electrocardiograms pattern showed that some other cardiac abnormalities are also associated with arrhythmias (Seferovic *et al*., 2006).

The antiarrhythmic potential of coriander seeds may be attributed to important bioactive polyphenolic compounds. Polyphenolic contents have ability to scavenge the free radicles and reduce myocardial damage caused by free radicals (Zafar *et al*., 2015; Omnia *et al*., 2014). It has been also reported that polyphenol compounds help in regulating heart rate by binding with beta-adrenergic receptors and have negative chronotropic effect that may delay the action potential in myocytes so, arrhythmias could be prevented (Dianat *et al.,* 2014). Same trends were observed in many previous findings (Murugesan *et al*., 2012; Ramadoss *et al*., 2012; Ammar *et al*. 2014). Certain studies also illustrated that the anti-arrhythmic activity of *C. sativum* may be due to the presence of certain alkaloids (Saxena *et al*., 2013). Some alkaloids treat the cardiac arrhythmia by controlling the inward and out ward flow of Na^+ and K^+ current (Chukwuebuka and Chinenye, 2015).

Conclusions: *Coriander sativum* reduced the pulse rate, normalized ECG patterns and level of cardiac biomarkers without imparting any harmful effect and found equally good in bradycardia. Therefore, it is concluded that oral administration of *C. sativum* seeds can attenuate both type of cardiac arrhythmias.

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