

Effects of garlic (*Allium sativum*) extract on the heart rate, rhythm and force of contraction in frog: A dose-dependent study

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Garlic juice (dose equivalent to 3.3 g to 33 g garlic) mainly caused bradycardia in frog *Rana tigerina*. The disturbance in ventricular rhythm was observed prior to than that of atria. Rhythm was specially disturbed at higher doses causing bizarre pattern. Force of contraction of the heart also decreased with higher dose of the garlic extract. The results suggest that garlic extract has some beneficial effect on heart rate modulating the rate, rhythm and force of contraction positively but very high doses may exert non-desirable effects as well.

Keywords: Force of contraction, Garlic extract, Heart rate, Heart rhythm

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Cardiac arrhythmias are disruptions in the natural rhythm of the heartbeat normally caused by improper functioning of the electrical system of cells in the heart and are cause of almost half of the deaths in patients with heart failure. It is seen that ventricular premature systoles and tachycardias precede acute myocardial infarction. Tachycardia increases the heart's workload and can also lead to increased arterial damage, opening the door for atherosclerosis. Associations between garlic (*Allium sativum*) consumption and decreased cardiovascular morbidity and mortality have been suggested along with antihypertensive properties¹. The oral ingestion of garlic or its essential oils has been suggested to exhibit hypolipemic effect in experimental animals with induced atherosclerosis^{2,3}. Cardiogenic, antihyperlipemic and antiatherogenic effects of garlic have been further suggested⁴. Garlic has a significant

antiarrhythmic effect on the heart, suppressing premature ventricular contractions and tachycardia⁵. However, there is a lack of data supporting the effects of garlic extract on heart with varying doses in relation to heart rate, rhythm and force of contraction. Therefore the present study has been undertaken to affirm the suppressive effects of garlic on tachycardia, rhythm and force of contraction of heart, in a dose-dependant manner.

Fresh garlic (*Allium sativum*)⁶ juice was extracted by crushing garlic cloves (15 ml/100 g). This pure undiluted juice was used throughout the experiments. After obtaining ethical clearance from the Institute [also complying with ethics prepared by INSA, Animal Welfare Division of the Ministry of Environment and Forest, Council of International Organization of Medical Sciences (WHO/UNESCO), NIH and PHS], 20 frogs (*Rana tigerina*) of average size, obtained from the animal supplier to the Department of Physiology, King George's Medical College, Lucknow, were used. Each frog was dissected from ventral surface to expose the heart and pericardium was removed. The experimental animals served as self controls i.e. same animals were used in both the circumstances. Firstly the heart activity was recorded in frogs without exposing them to garlic extract by using 'Student Physiograph' (Sensitivity 50 μ V and speed 5 mm/sec.). Thereafter, the garlic juice was directly poured over the exposed hearts in a dose-dependent manner i.e. 0.5, 1, 1.5, 2, 3, 4 and 5 ml as recommended in laboratory manual⁷. The heart activity recording included heart rate, rhythm and force of contraction. After recording heart activity in each case, a washout for preceding dose of garlic extract was strictly followed.

Statistical analysis—The results were analyzed using SPSS 11.0 for Windows. Multivariate analysis was performed, keeping alpha at 0.05 and confidence interval of 95%.

Rate—The garlic mainly caused bradycardia (Table 1). However at 0.5 ml dose initially slight tachycardia (statistically non-significant) was also noted in a good number of cases.

Rhythm—The disturbance in ventricular rhythm was observed prior to than that of atria. Rhythm was

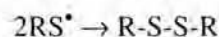
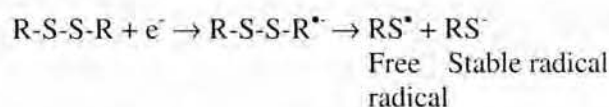
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specially disturbed at higher doses. The 4 ml to 5 ml dose of garlic in most cases caused bizarre pattern.

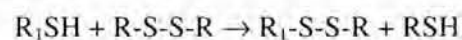
Force of contraction—Force of contraction of the heart decreased with higher dose of the garlic extract [Fig 1(a-f)].

Heart diseases are prime culprits in modern world for maximum number of deaths in Asian, American as well as European countries. There are several risk factors for cardiac diseases including cardiac arrhythmia. Cardiac arrhythmia may cause excess load on heart thereby tolling on heart physiological processes. Martin *et al.*⁸ have suggested that garlic dialysate has a significant antiarrhythmic effect on both ventricular and supraventricular arrhythmias. In the present study similar suppressive effect of garlic extract were observed on heart rate, in conjunction with prominent effect on the ventricular rhythm. In a previous study Martin *et al.*⁹ also showed that garlic dialysate led to decrease in heart rate in a dose-dependent manner. They explained the findings by a depressant effect on automaticity and tension development in the heart, suggesting a beta-adrenoceptor blocking action produced by the garlic dialysate. In another study by Isensee *et al.*¹⁰ showed that the incidence of ventricular tachycardia and fibrillation after ligation of the descending branch of the left coronary artery was significantly reduced in the garlic treated dogs as compared to untreated controls. A gradual decrease in heart rate, but not in arterial blood pressure of dogs was observed in a similar experiment during the course of the experimental periods by Pantoja *et al.*¹¹, the ECG was however, not affected. Pantoja *et al.*¹² also showed that high doses of garlic provoked bradycardia and T-wave inversion during first few minutes. In the present study, a

decrease in force of contraction of heart was observed. Aqel *et al.*¹³ showed that such action of garlic may be due to a direct relaxant action on heart. Garlic extract has been found to be rich in volatile oils (RSH, RS(O)SR, R-S_n-R; R=CH₃ and C₃H₅)¹⁴, calcium (30mg/100g), phosphorous (310 mg/100g), iron (1.2mg/100g), thiamine (0.06mg/100g), riboflavin (0.23mg/100g), niacin (0.4mg/100g), vitamin C (13mg/100g), magnesium (71mg/100g), copper (0.63mg/100g), manganese (0.86mg/100g), zinc (1.93mg/100g) and chromium (0.02 mg/100g)¹⁵. These components of garlic can be suggestive of some sort of free radical scavenging properties that come in play while exhibiting the anti-arrhythmic effect. The free radical scavenging action of garlic principal is as follows¹⁶:



The above steps are repeated. Disulphides may interact with thiol group enzymes and proteins (RSH)¹³ in the heart and that may modulate the rhythm of the heart.



Here RS of garlic oil is attached to the thiol part of tissues. Low intake of magnesium has been linked to high blood pressure and also with arrhythmia, therefore garlic as a good source of magnesium may help. Moreover, vitamin B group members and zinc present in garlic extract may also lower blood pressure and maintain regular heartbeat in people who have arrhythmia problems. Calcium is important for proper functioning of the cardiac (heart) muscle and is a companion to magnesium. It is suggested by Martin *et al.*¹⁷ that the negative inotropic effect of garlic dialysate is related to calcium ion availability. They also suggested that it is possible that restriction of intracellular calcium contributes to this negative inotropic effect. Low intake of selenium has been linked to heart disease and cardiovascular problems like arrhythmia. Therefore, garlic as a good source of almost all of these micronutrients may help in controlling arrhythmia and tachycardia.

Table I—Effect of garlic extract on heart rate (dose range is equivalent to 3.3 g to 33 g garlic).
[Values are mean \pm SD]

Dose (ml)	Heart rate (per min)	Range	
		Minimum	Maximum
Control	60.0 \pm 0.198	58	62
0.5	60.65 \pm 1.2 *	59	63
1	52.5 \pm 0.756 **	51	54
1.5	36.15 \pm 0.457 **	34	36
2	31.5 \pm 1.213 **	30	32
3	30.3 \pm 0.879 **	30	31
4	26.65 \pm 1.014 **	26	28
5	15.7 \pm 0.887 **	12	16

P values * NS = non-significant; ** <0.05

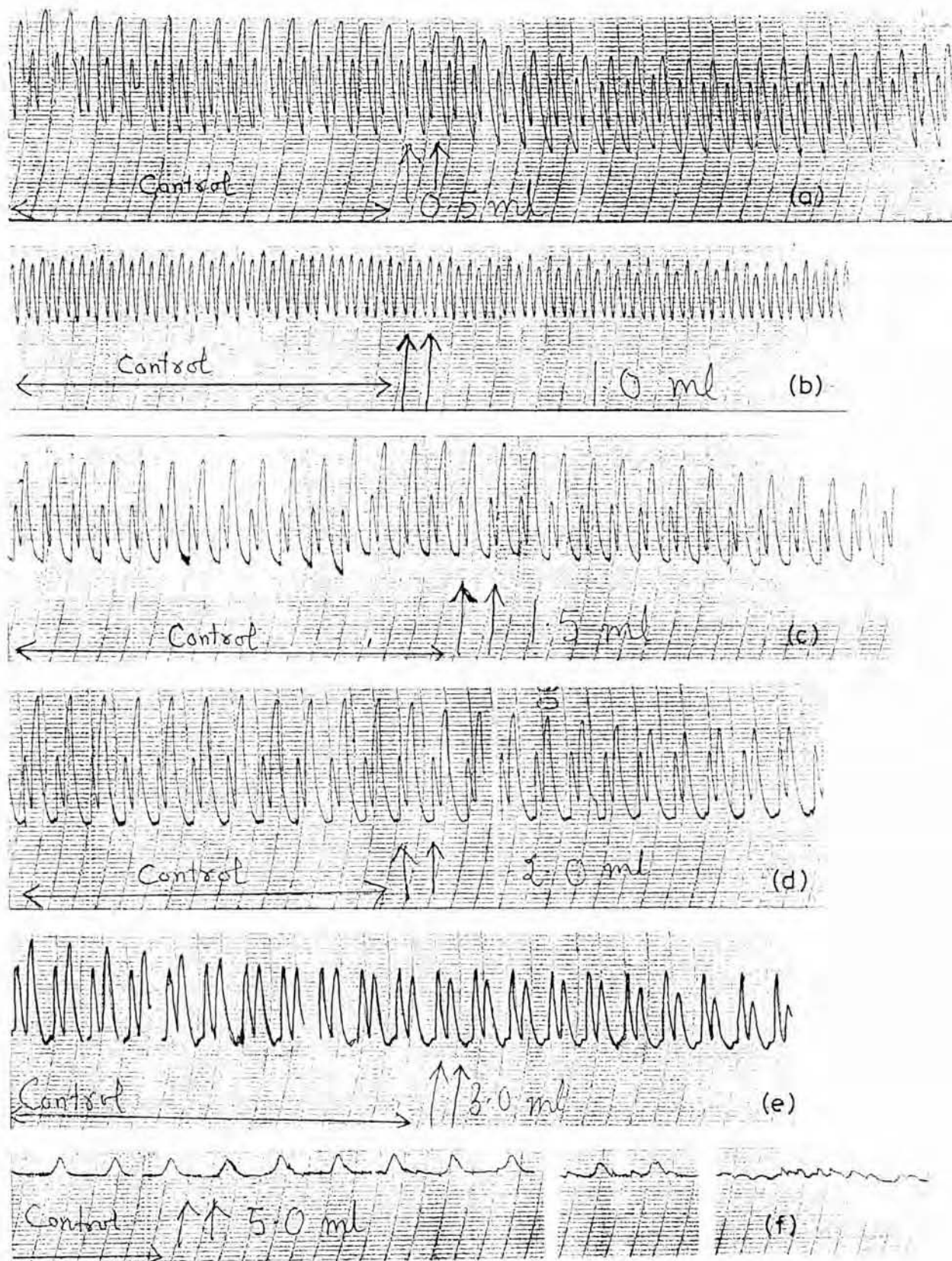


Fig. 1—Cardiogram of frog following 0.5 ml (a), 1 ml (b), 1.5 ml (c), 2 ml (d), 3 ml (e) and 5 ml (f) garlic extract

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