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Effect of aqueous extract of the leaves of *Sansevieria liberica* Gérôme and Labroy on blood pressure indices and pulse rates of sub-chronic salt-loaded rats

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Abstract

The effects of aqueous leaf extract of *Sansevieria liberica* on the blood pressure parameters and pulse rates of sub-chronic salt-loaded rats were investigated. The control group received a diet consisting 100% of the commercial feed, while the four test groups received an 8% salt-loaded diet all through, except for the reference treatment group that had its salt-loading discontinued after six weeks. The extract was orally administered daily at 200 and 250mg/kg body weight; while the test control, reference and control groups received appropriate volumes of water by the same route. The extract immediately, dose dependently lowered the systolic pressure of the rats; although, the effect become only significant at 3 hr (for both doses) and 192 hr (for the 200 mg/kg dose). The 200 mg/kg dose produced alternating effects on the diastolic, pulse and mean arterial pressures; while the 250 mg/kg dose produced an initial reduction in diastolic and mean arterial pressures (maintained until the 192nd hr before increasing) and a consistent reduction in pulse pressure. The pulse rate of the test groups were relatively more stable and lower on the average, compared to the test control. This result indicates that the extract may probably manage hypertension by alteration of the systolic and pulse pressures; and in addition, confirms the use of the plant in the management of hypertension in traditional medicine practice.

Keywords: Blood pressure parameters, hypertension, pulse rates, salt-loading, *Sansevieria liberica*

1. Introduction

The relative contribution of blood pressure components (systolic blood pressure, SBP; diastolic blood pressure, DBP; pulse pressure, PP and mean arterial pressure, MAP) to cardiovascular risk is still uncertain. They are associated with coronary heart disease and all-cause mortality, in addition to stroke mortality, among hypertensive and normotensive men [1] Their contributions to cardiovascular disease change across the lifespan: from DBP to SBP and ultimately to pulse pressure [2,3,4,5]. Any consistent elevation of blood pressure, slight or marked, systolic or diastolic, is associated with increased morbidity and mortality [6]. Mean arterial pressure is slightly more informative in the prediction of coronary heart disease and

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all-cause mortality in single blood pressure index models and equal to models with diastolic blood pressure and systolic blood pressure or pulse pressure [1].

Fast heart rate is a potent precursor of hypertension, atherosclerosis, and their sequelae [7,8]. It has also been associated with an increased risk of death from cardiovascular and noncardiovascular causes. This relationship has been found in general populations, in elderly individuals, and in hypertensive cohorts [9].

Antihypertensive drug therapy substantially reduces the risk of hypertension-related morbidity and mortality [10,11]. Currently, several effective antihypertensive drugs, including diuretics,β-blockers, calcium channel blockers, angiotensin converting enzyme inhibitors, and angiotensin receptor blockers are available for hypertension therapy [11]. All classes of drugs reduce cardiovascular disease mortality equally; and different classes of drugs provide differing degrees of protection from cardiovascular dissease morbidities.

Sansevieria liberica (family Agavaceae, Ruscaceae or Dracaenaceae), is one of the sixty species in genus Sansevieria, commonly called bowstring hemp [12]. It has concave, short petioled leaves that are in part transversely banded with light and dark green, also linearly striated with whitish to light green and dark green striations [13]. The leaves and roots of Sansevieria liberica are used in traditional medicine for the treatment of asthma, abdominal pains, colic, diarrhea, eczema, gonorrhea, hemorrhoids, hypertension, monorrhagia, piles, sexual weakness, snake bites and wounds of the foot [14,15,16]. The sedative, anticonvulsant and antidiarrhoeal activities of the roots have been studied [15,17]. In view of the dearth of information in the literature, regarding the evaluation of the hypotensive property of this plant, the present study was undertaken to investigate the effect of aqueous extract of leaves of *Sansevieria liberica* on the blood pressure parameters and pulse rates of sub-chronic salt-loaded rats.

2. Materials and methods

2.1 Preparation of Plant Extract

Samples of fresh *Sansevieria liberica* plants were procured from a horticulturist by Air Force Gate, Aba Road, Port Harcourt and a horticultural garden by the main gate of the Abuja campus of the University of Port Harcourt, Nigeria. After due identification at the University of Port Harcourt Herbarium, they were rid of dirt and the leaves were removed, oven dried at 55°C and ground into powder. The resultant powder was soaked in boiled, hot distilled water for 12 hr, after which the resultant mixture was filtered and the filtrate, hereinafter referred to as the aqueous extract was stored in a refrigerator for subsequent use. A known volume of this extract was evaporated to dryness, and the weight of the residue used to determine the concentration of the filtrate, which was in turn used to determine the dose of administration of the extract to the test animals.

2.2 Experimental Design

Wistar albino rats (160-200 g) were collected from the animal house of the Department of Physiology, University of Nigeria, Enugu Campus. Studies were conducted in compliance with applicable laws and regulations. All the experiments were conducted in accordance with the internationally accepted principles for laboratory animal use and care as found in the European Community Guidelines (EEC Directive of 1986; 86/609/EEC). The rats were sorted into five groups of five animals each, so that the average weight difference was $\leq$1.8 g. The animals were housed in plastic cages in the animal house of the Department of Biochemistry, University of Port Harcourt. After a one-week acclimatization period on guinea growers mash (Port Harcourt Flour Mills, Port Harcourt, Nigeria), the treatment commenced and lasted for seven weeks. The control group received a diet consisting 100% of the commercial feed, while the four test groups received a diet consisting 8% salt and 92% commercial feed. The 8% dietary salt-loading was adapted from Obiefuna *et al.* [18] and Ikewuchi *et al.* [19,20]. At the end of the sixth week, the rats were weighed and their blood pressure and pulse rate were determined, before commencing the administration of the extract, while the reference treatment group had its salt-loading discontinued. The first test group [SL 1] received daily by intra-gastric gavages 200 mg/kg body weight of the *Sansevieria liberica* extract; the second group (SL 2) received 250 mg/kg body weight of the *Sansevieria liberica* extract; while the other three groups, test control, reference treatment (reference) and control groups received appropriate volumes of water by the same route. The dosage of administration of the extract was adapted from Ikewuchi *et al.* [21] The salt removal as a therapy for hypertension was adapted from O'Shaughnessy and Karet [22]. The animals were allowed food and water *ad libitum*. The blood pressures and pulse rates were measured at 3, 24, 72 and 192 hrs.

2.3 Determination of Blood Pressure and Pulse Rate of the Rats

The systolic (SBP) and diastolic (DBP) blood pressures and the pulse rate of the rats were measured via femoral pulse, using Omron RX Classic™ sphygmomanometer (OMRON Healthcare UK, LTD). The pulse pressure (PP) and mean arterial pressure (MAP) were calculated mathematically from Systolic (SBP) and diastolic (DBP) blood pressures according to Freitag *et al.*[4] and Nworgu *et al.*[23] sing the following formulae.

$$\text{Pulse pressure} = \text{Systolic} - \text{Diastolic pressure}$$

$$\text{Mean arterial pressure} = \text{Diastolic pressure} + \frac{\text{Systolic pressure} - \text{Diastolic pressure}}{3}$$

2.4 Statistical Analysis of Data

All values are reported as the mean ± SD. The values of the various parameters were analyzed for statistical significant differences between the groups using the Student's *t*-test, with the help of SPSS Statistics 17.0 package (SPSS Inc., Chicago Ill). $P<0.05$ was assumed to be significant.

3. Results

Time course of the effect of aqueous extract of the leaves of *Sansevieria liberica* on the systolic blood pressure of sub-chronic salt-loaded rats is given in Fig 1. There were no significant differences in the systolic pressures of all the groups at 0 hr, though that of SL 2 was the highest. At 3 hr, the systolic pressure of test control was not significantly higher than the other groups.There were no significant differences in the systolic pressures of all the groups at 24 and 72 hrs. At 192 hr, the systolic pressure of SL1 was significantly lower ($P<0.05$) than test control, but not different from control, reference and SL 2. Fig 2 shows the time course of the effect of aqueous extract of *Sansevieria liberica* on the diastolic pressure of sub-chronic salt-loaded rats. There were no significant differences in the diastolic pressures of all the groups at 0, 3, 24 and 72 hrs. At 192 hr, the diastolic pressure of SL2 was significantly higher ($P<0.05$) than reference, but not significantly higher than control, test control and SL 1. Compared to corresponding values at 0 hr, reference at 24 hr, was significantly higher (P<0.05).

Fig 3 shows the time course of the effect of aqueous extract of the leaves of *Sansevieria liberica* on the pulse pressure of sub-chronic salt-loaded rats. At 0 hr, the pulse pressure of SL 2 was significantly higher (P<0.05) than control, but not significantly higher than test control (the least), reference and SL 1. At 3, 24 and 72 hrs, there were no significant differences in the pulse pressures of all the groups. At 192 hr, the pulse pressure of test control was significantly higher (P<0.05) than control and reference, but not significantly higher than the test groups. Compared to corresponding values at 0 hr, test control, at 192 hr was significantly higher (P<0.05). The time course of the effect of aqueous extract of the leaves of Sansevieria liberica on the mean arterial pressure of sub-chronic salt-loaded rats is shown in Figure 4. There were no significant differences in the mean arterial pressures of all the groups at 0, 3, 24, 72 and 192 hrs.

The time course of the effect of aqueous extract of the leaves of *Sansevieria liberica* on the pulse rate of sub-chronic salt-loaded rats is given in Fig 5. At 0 hr, the pulse rate of SL 2 was significantly lower (P<0.05) than SL 1; the test groups were not significantly different from control, test control and reference. At 3 hr, the pulse rate of SL1was significantly higher (P<0.05) than test control, significantly lower (P<0.05) than reference, but not different from control and SL 2. The pulse rate of test control at 24 hr, was significantly higher (P<0.05) than control, but not significantly higher than reference and the test groups; though SL 2 had the least value. There were no significant differences in the pulse rates of all the groups at 72 hr. The pulse rate of SL 1 at 192 hr, was significantly lower (P<0.05) than test control and reference, but not significantly lower than control and SL 2. Compared to corresponding 0hr values, the pulse rate of reference was significantly higher (P<0.05) at 192 hr.

Effect of aqueous extract of the leaves of *Sansevieria liberica* on the percentage change in blood pressure and pulse rates of sub-chronic salt-loaded rats is given in Table 1. The percentage decrease in systolic pressure at 3 hr for SL 2 was no significantly higher than the other groups (with test control being the least). The percentage decreases in systolic pressures of SL 2 at 24 and 72 hrs were not significantly higher than the other groups. There were no significant differences in the percentage decreases in systolic pressures for all the groups at 192 hr, though test control had the least value. There were no significant differences in the percentage decreases in diastolic pressures of all the groups, at 3 and 192 hrs. The percentage decrease in diastolic pressures of SL 2, at 24 and 72 hrs, were significantly higher (P<0.05) than reference, but not significantly higher than control, test control and SL 1. The percentage decreases in pulse pressures of the test groups at 3 hr, were not significantly higher than control, test control and reference. The percentage decrease in pulse pressure of SL 2, at 24 hr, was not significantly higher than test control (the least), reference and SL 1. The percentage decrease in pulse pressure of the test groups, at 72 hr, were higher than control and test control, but lower than reference.There were no significant differences in the percentage decreases in mean arterial pressures of all the groups at 3,72 and 192 hrs.The percentage decrease in mean arterial pressure of SL 2 at 24 hr, was significantly higher (P<0.05) than reference, but not significantly higher than control, test control and SL 1. The percentage decrease in pulse rate of SL 2 at 3 hr, was significantly lower (P<0.05) than test control, but not different from control, reference and SL 1.There were no significant differences in the percentage decreases in pulse rates of all the groups at 24, 72 and 192 hrs.

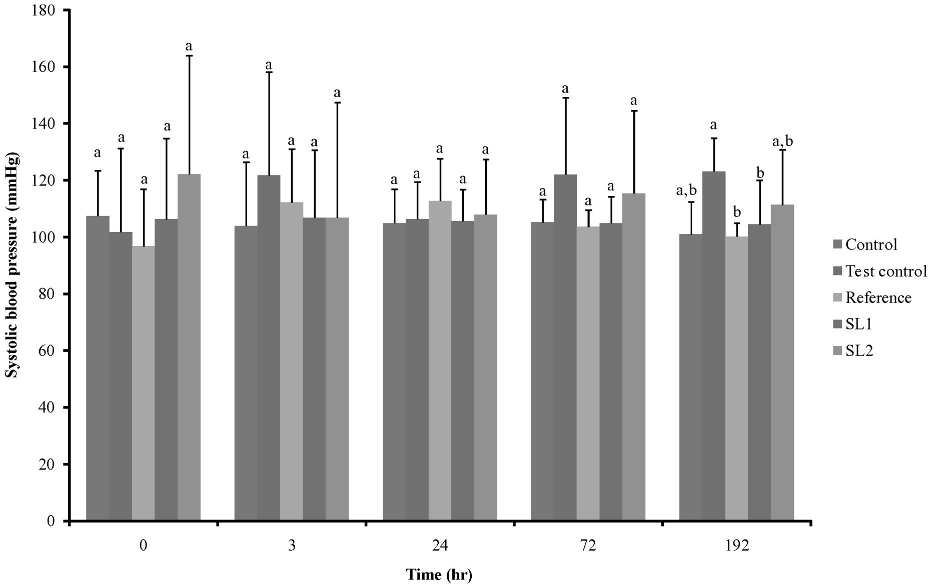

Fig. 1. Time course of the effects of an aqueous extract of the leaves of *Sansevieria liberica* on the systolic blood pressure of sub-chronic salt-loaded rats. Values are mean ± SD, n=5, per group. [a,b]Values in the same column group with the different superscripts are significantly different at $P<0.05$.

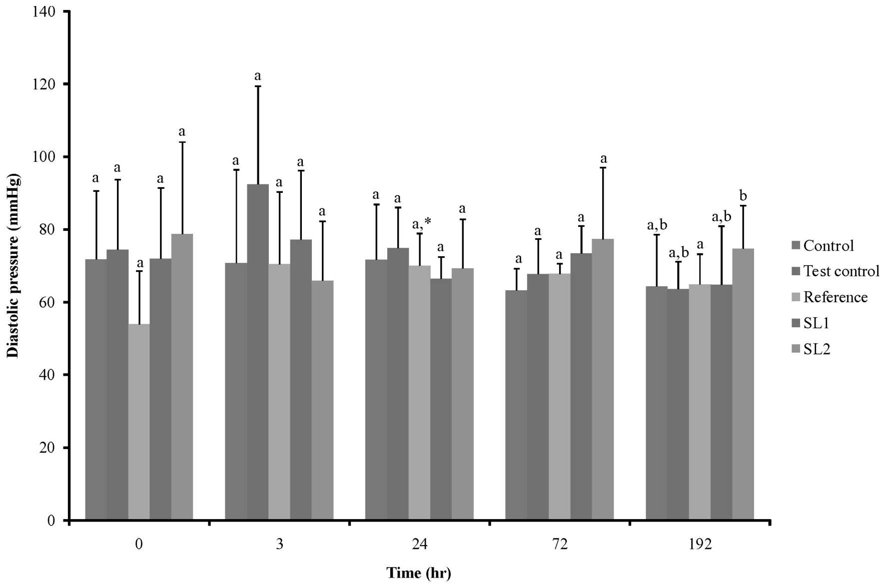

Fig. 2. Time course of the effects of an aqueous extract of the leaves of *Sansevieria liberica* on the diastolic blood pressure of sub-chronic salt-loaded rats. Values are mean ± SD, n=5, per group. [a,b]Values in the same column group with the different superscripts are significantly different at $P<0.05$. $*P<0.05$ compared to corresponding 0 hr value.

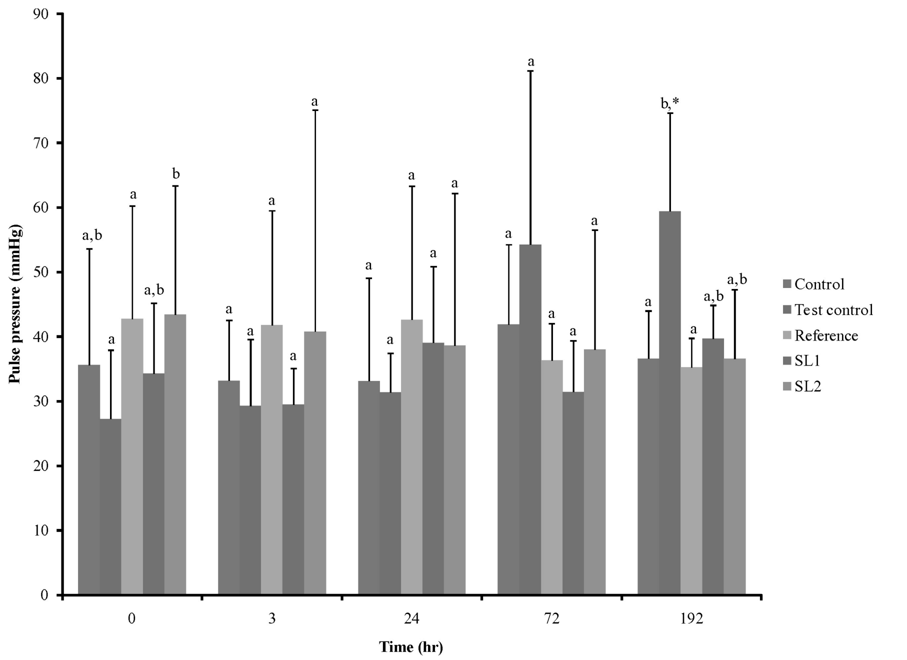

Fig. 3. Time course of the effects of an aqueous extract of the leaves of *Sansevieria liberica* on the pulse pressure of sub-chronic salt-loaded rats. Values are mean ± SD, n=5, per group. [a,b]Values in the same column group with the different superscripts are significantly different at $P<0.05$. $^*P<0.05$ compared to corresponding 0 hr value.

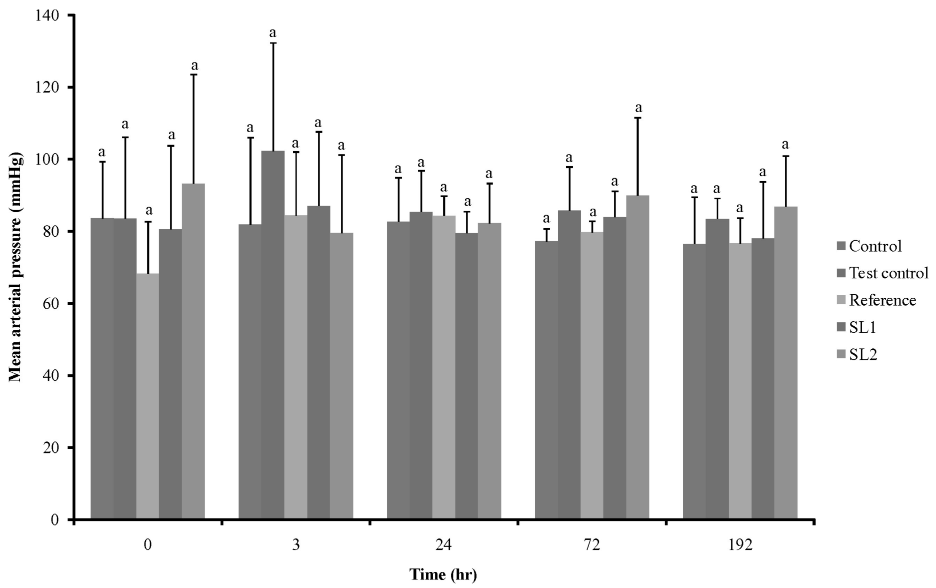

Fig. 4. Time course of the effects of an aqueous extract of the leaves of *Sansevieria liberica* on the mean arterial pressure of sub-chronic salt-loaded rats. Values are mean ±SD, n=5, per group. [a]Values in the same column group with the different superscripts are significantly different at $P<0.05$.

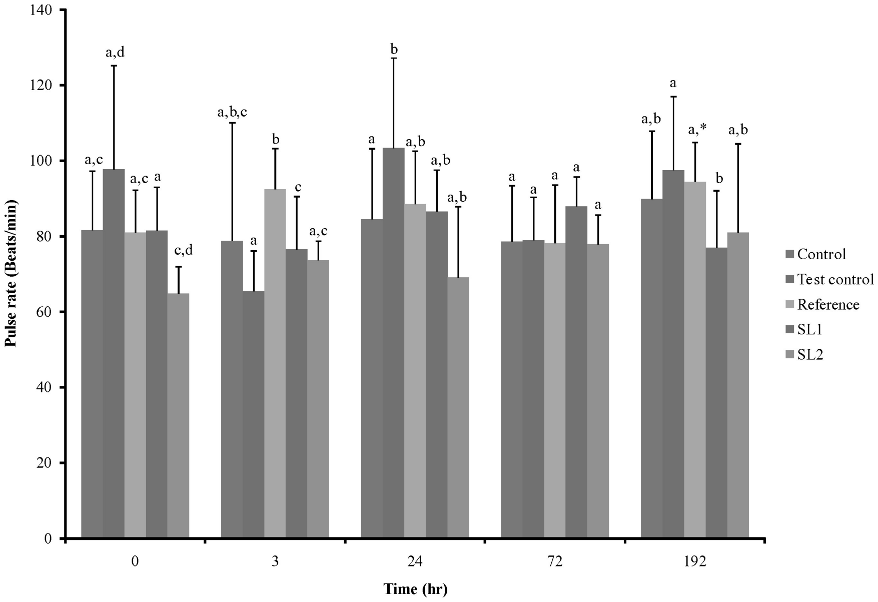

Fig. 5. Time course of the effects of an aqueous extract of the leaves of *Sansevieria liberica* on the pulse rate of sub-chronic salt-loaded rats. [a,b,c]Values are mean ± SD, n=5, per group. [a,b]Values in the same column group with the different superscripts are significantly different at $P<0.05$. *$P<0.05$ compared to corresponding 0 hr value.

4. Discussion

The extract immediately lowered the systolic pressure of the rats Fig 1. Although, the effect stabilized with time, was dose dependent, and become only significant at 3 hr (for both doses) and 192 hr (for the 200 mg/kg dose). The 200 mg/kg dose produced alternating effects on the diastolic pressure, while the 250 mg/kg dose produced an initial reduction, which it maintained until the 192 hr when an increase resulted. The effect may be the results of adaptation of the animals to the extract: probable due to increased clearance of the active principles, thus lowering their effective concentration and subsequent removal. The 200 mg/kg dose had an alternating effect on the pulse pressure of the rats, while the 250 mg/kg dose produced a consistent reduction. Given the fact that the salt loading continued during the treatment, Fig 3 shows that the extract (especially at 250 mg/kg) prevented the salt-loading induced upsurge in pulse pressure between the 72^{nd} and 192^{nd} hrs. Increased pulse pressure predicts cardiovascular and coronary artery disease, myocardial infarction, and congestive heart failure, independent of diastolic blood pressure and systolic blood pressure, other risk markers, and 'white coat' hypertension [3]. The predictive potential of pulse pressure may be due to the fact that increased systolic blood pressure increases end-systolic stress and promotes cardiac hypertrophy; whereas reduceddiastolic blood pressure reduces coronary perfusion promoting myocardial ischaemia and is associated with increased cardiovascular risk [3].The 200 mg/kg dose produced alternating effects on the mean arterial pressure, while the 250 mg/kg dose produced an initial reduction, which it maintained until the 72 and 192 hr when an increase resulted. The effect may be the result of adaptation of the animals to the extract: probable due to increased clearance of the active principles, thus lowering their effective concentration, and their subsequent removal. The extract produced relatively stable pulse rate in the test animals compared to the test control; these were on the average, lower than the test control. Fast heart rate is associated with an increased risk of death from cardiovascular and noncardiovascular causes [9]. Therefore, the lowered heart rate produced by the extract portends its ability to reduce cardiovascular risk.

The implication of this result is that the extract may probably manage hypertension by alteration of the systolic and pulse pressures. The result also confirms the use of the plant in the management of hypertension in traditional medicine practice.

Table 1
Effects of an aqueous extract of the leaves of *Sansevieria liberica* on the percentage change in blood pressure and pulse rates of sub-chronic salt-loaded rats

Parameter	Magnitude				
	Control	**Test control**	**Reference**	**SL 1**	**SL 2**
Systolic Blood Pressure					
3 hr	-6.81±16.88[a]	30.39±53.31[a]	22.57±43.11[a]	8.76±40.99[a]	-6.90±37.77[a]
24 hr	-1.47±10.75[a]	11.94±36.24[a]	22.35±37.53[a]	4.19±24.69[a]	-4.20±31.79[a]
72 hr	-0.80±11.78[a]	31.40±54.34[a]	11.15±24.97[a]	4.11±26.57[a]	-0.33±33.23[a]
192 hr	-5.07±10.59[a]	27.76±31.61[a]	7.45±24.49[a]	4.52±31.40[a]	-0.27±37.16[a]
Diastolic Blood Pressure					
3 hr	-1.41±24.15[a]	32.21±48.28[a]	37.33±55.21[a]	17.36±48.51[a]	-1.58±49.41[a]
24 hr	1.56±14.52[a]	6.31±34.87[a,b]	33.40±18.10[b]	-1.57±28.73[a,b]	-3.26±38.99[a]
72 hr	-7.45±21.43[a,b]	-2.59±34.36[a,b]	31.85±29.45[a]	8.79±31.59[a,b]	0.72±15.34[b]
192 hr	-7.80±22.19[a]	-10.32±25.45[a]	27.02±35.76[a]	-2.81±40.82[a]	4.32±39.03[a]
Pulse Pressure					
3 hr	7.07±47.05[a]	27.89±72.44[a]	14.07±63.97[a]	-6.22±31.66[a]	-12.22±35.17[a]
24 hr	5.38±61.82[a]	31.37±58.21[a]	11.39±69.77[a]	17.43±27.46[a]	11.24±95.16[a]
72 hr	35.14±56.46[a,b]	141.73±174.93[a,b]	-6.98±29.39[a]	-4.81±23.76[a]	2.90±75.82[a,b]
192 hr	27.31±68.39[a]	143.47±112.14[b]	-7.45±32.51[a]	30.99±64.02[a,b]	-7.10±37.31[a]
Mean Arterial Pressure					
3 hr	-2.49±20.28[a]	31.43±50.20[a]	29.75±44.50[a]	17.85±45.02[a]	-5.46±44.70[a]
24 hr	-0.32±7.66[a,b]	8.55±35.04[a,b]	27.44±24.95[a]	24.82±20.55[a,b]	-4.22±33.28[b]
72 hr	-5.78±15.44[a]	10.90±39.71[a]	21.12±25.12[a]	10.84±29.53[a]	0.01±21.44[a]
192 hr	-7.79±11.45[a]	5.48±26.50[a]	16.60±27.51[a]	3.85±36.12[a]	2.23±37.98[a]
Pulse Rate					
3 hr	-3.00±31.58[a,b]	-27.16±30.21[a]	15.59±19.06[b]	-3.67±25.70[a,b]	14.66±14.52[b]
24 hr	3.73±10.56[a]	12.44±34.24[a]	10.77±22.31[a]	6.00±16.50[a]	8.10±34.96[a]
72 hr	-1.87±18.59[a]	-12.56±25.56[a]	-1.34±27.85[a]	8.42±21.24[a]	21.68±21.20[a]
192 hr	6.57±17.66[a]	14.22±69.89[a]	16.95±7.32[a]	-4.34±21.56[a]	27.09±45.85[a]

Values are mean ± SD, n=5, per group. [a,b,c]Values in the same row with the different superscripts are significantly different at $P<0.05$. Percentage change = percentage change from corresponding 0 hr value.

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