Effect of Licorice Root on Peripheral Blood Indexes upon Vibration Exposure

Ts. I. Adamyan, E. S. Gevorkyan, S. M. Minasyan, K. R. Oganesyan, and K. A. Kirakosyan

Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 140, No. 8, pp. 164-168, August, 2005
Original article submitted October 21, 2004

We studied the effect of continuous vibration and treatment with licorice root (*Glycyrrhiza glabra L.*) on peripheral blood red cells in rabbits. Active substances of licorice root accelerated metabolism in cells of the bone marrow erythroid stem, enhanced compensatory reserve of the organism, and increased animal's resistance to stress.

Key Words: *vibration; licorice root; erythrocytes; reticulocytes*

The number of factors producing an adverse effect on the human organism significantly increased in recent years. Vibration is one of the most abundant adverse factors. Exposure to moderate vibration for a short time stimulates various physiological functions in the organism. Short-term vibrotherapy is widely used for the treatment of cardiovascular and eye diseases, radiculitis, trophic disorders, bronchial asthma, and other disturbances [11]. Similarly to other physical agents, continuous exposure of the whole organism to vibration produces phasic changes in the autonomic homeostatic functions (blood pressure, vascular tone, blood composition, cardiorespiratory equilibrium, *etc.*), which is accompanied by variations in bioelectric activity of the brain [1,4-6]. In modern medicine and biology much attention is paid to a decrease in the incidence of vibration-associated disorders and search for new drugs and methods increasing the resistance to vibration.

In recent years plant preparations were extensively used as a folk medicine to increase organism's resistance and treat various diseases. One of these preparations is licorice root (*Glycyrrhiza glabra L.*). Previous experiments demonstrated antiallergic, hypolipidemic, antisclerotic, and antiviral properties of licorice plants [8,9]. At the present time licorice is a common medicinal plant [3].

Department of Human and Animal Physiology, Erevan State University.
Address for correspondence: anatom@ysu.am. Ts. I. Adamyan

Here we studied whether treatment with licorice roots can alleviate a negative effect of vibration and increase organism's resistance to this stress factor.

MATERIALS AND METHODS

Experiments were performed on adult chinchilla rabbits weighing 2.5-3.0 kg and kept under standard environmental and feeding conditions. Group 1 animals were daily placed in a muffler chamber and exposed to vibration on an EV-1 vibration table (frequency 60 Hz, amplitude 0.4 mm) for 30 days. Group 2 animals fed licorice root (150 mg/100 g) for 30 days. Group 3 animals were exposed to vibration and received licorice root for 30 days.

Erythrocyte count (per 1 mm^3 blood), hemoglobin concentration, color index, and relative (%) and absolute number of reticulocytes (per 1 mm^3 blood) were measured on days 5, 10, 15, 20, 25 and 30 under normal conditions. The blood was sampled from the marginal auricular vein. Erythrocytes were counted in a Goryaev chamber. Hemoglobin concentration was measured in a Sahli's hemometer. The color index was calculated by a special formula. The relative number of reticulocytes was determined by the method of Egorov. The absolute number of reticulocytes was estimated taking into account erythrocyte number per 1 mm^3 blood and ratio of reticulocytes.

The results were analyzed by Student's *t* test.

0007-4888/05/1402-0197

RESULTS

Peripheral blood changes in group 1 animals depended on the period of vibration. Vibration exposure for 5 and 10 days was followed by a hypochromic shift in peripheral blood red cells. Under these conditions erythrocyte count increased by 5.45 and 12.72%, respectively ($p<0.2$). The absolute and relative number of reticulocytes increased most significantly after vibration exposure for 5 (by 40.1 and 33.3%, respectively) and 10 days (by 69.9 and 50.0%, respectively, $p<0.001$). The color index slightly decreased in these periods, which was probably associated with a disproportional increase in erythrocyte count and hemoglobin concentration (Table 1).

The increase in erythrocyte count and hemoglobin concentration after 10-day vibration exposure is related to activation of the sympathetic mechanism for redistribution of peripheral blood cells and migration of immature red blood cells from the bone marrow. It was supported by a significant increase in reticulocyte count. A normochromic decrease in erythrocyte count and hemoglobin concentration was observed after vibration exposure for 15 and 30 days. Other parameters underwent similar variations (Table 1). These changes in peripheral blood red cells during continuous vibration probably result from inhibition of proliferation in the bone marrow erythroid stem.

A moderately normochromic decrease in erythrocyte count and hemoglobin concentration was observed in group 2 animals on day 5 of treatment with *Glycyrrhiza glabra L.* (Table 2). Color index did not differ from the basal level. In this period the relative number of reticulocytes increased by 5.9%, while the absolute number of cells remained unchanged. These changes reflect activation of the parasympathetic mechanisms of peripheral blood red cell redistribution. Hypochromia of red blood cells was revealed on day 10. Erythrocyte count exceeded the basal level by 14.77% ($p<0.02$). Hemoglobin concentration did not differ from normal. The color index decreased by 11.1%. The observed changes were probably associated with migration of immature erythrocytes from the bone marrow into circulation. This assumption is supported by the increase in the absolute number of reticulocytes to 141.78% ($p<0.001$).

Feeding of licorice plants for 15 days was followed by progressive activation of erythropoiesis: erythrocyte count and hemoglobin concentration increased by 15.2 ($p<0.01$) and 11.1% ($p<0.02$), respectively. The relative and absolute number of reticulocytes reached maximum (147.05 and 169.35%, respectively, $p<0.001$). These data show that *Glycyrrhiza glabra L.* activates proliferation and maturation in the bone marrow erythroid stem.

TABLE 1. Peripheral Blood Red Cells during Vibration Exposure (*M*±*m*)

Parameter	Basal level	Day					
		5	10	15	20	25	30
Erythrocyte count per 1 mm^3 blood, thousands	5500±180	5800±175	6200±240**	5200±168	4800±155**	4700±150***	4400±148****
Hemoglobin concentration, g%	14.00±0.28	13.80±0.29	15.20±0.31*	13.00±0.31*	12.20±0.22**	12.0±0.2***	11.20±0.19****
Color index	0.76	0.71	0.73	0.75	0.76	0.76	0.76
Relative number of reticulocytes, %	18.00±0.382	4.00±1.55****	27.00±1.82****	25.00±1.60****	20.00±0.68*	16.00±0.56**	16.00±0.57**
Absolute number of reticulocytes per 1 mm^3 blood	99,000±2900	139,200±3568****	167,400±3755****	130,000±3525****	96,000±2615	75,200±2219***	70,400±2210****

Note. Here and in Tables 2 and 3: *$p<0.05$, **$p<0.02$, ***$p<0.01$, and ****$p<0.001$ compared to the basal level.

TABLE 2. Peripheral Blood Red Cells in Rats Receiving Licorice Root (*M*±*m*)

Parameter	Basal level	Day					
		5	10	15	20	25	30
Erythrocyte count per 1 mm^3 blood, thousands	5210±168	4850±145	5980±180**	6000±189***	5500±173	5600±169	5800±170*
Hemoglobin concentration, g%	12.60±0.27	11.60±0.23**	12.60±0.25	14.00±0.29**	14.20±0.28**	14.40±0.29***	14.60±0.26****
Color index	0.72	0.72	0.64	0.70	0.77	0.77	0.75
Relative number of reticulocytes, %	17.00±0.38	18.00±0.37	21.00±0.52***	25.00±0.58****	23.00±0.51****	20.00±0.53**	20.00±0.53**
Absolute number of reticulocytes per 1 mm^3 blood	88,570±2885	87,300±2900	125,580±3545****	150,000±3658****	126,500±3540****	112,000±3245***	116,000±3236****

TABLE 3. Peripheral Blood Red Cells in Rats Receiving Licorice Root and Exposed to Vibration (*M*±*m*)

Parameter	Basal level	Day					
		5	10	15	20	25	30
Erythrocyte count per 1 mm^3 blood, thousands	4440±143	4890±145*	5493±168***	5396±159***	5186±145**	4900±148*	5430±163***
Hemoglobin concentration, g%	12.60±0.26	12.20±0.22	12.60±0.25	13.30±0.21	13.00±0.25	13.40±0.25	13.40±0.26
Color index	0.85	0.76	0.70	0.75	0.76	0.82	0.74
Relative number of reticulocytes, %	16.00±0.31	17.00±0.32	20.00±0.35***	22.00±0.34****	22.00±0.34****	18.00±0.29*	18.00±0.28*
Absolute number of reticulocytes per 1 mm^3 blood	71,040±2148	83,130±2545**	109,860±3443****	118,712±3485****	114,092±3412****	88,200±2550***	97,740±2765****

The test parameters were relatively high on days 20, 25, and 30.

We revealed no significant changes in peripheral blood red cells from group 3 animals. Hypochromia was observed on day 5. Erythrocyte count increased by 10.13% ($p<0.05$), while hemoglobin concentration decreased by 3.1%. Therefore, the color index decreased by 10.59% compared to the basal level. In this period the absolute and relative reticulocyte counts increased by 17.00 and 6.25%, respectively.

Hypochromia persisted on day 10. Hemoglobin concentration increased to the basal level. Erythrocyte count exceeded the basal level by 23.71% ($p<0.01$). The absolute and relative number of reticulocytes reached 154.6 and 125.0%, respectively ($p<0.001$). These changes reflect an increase in compensatory reserve of the organism.

Further activation of erythropoiesis in group 3 animals was observed on days 15-30 (Table 3). The observed changes in peripheral blood red cells reflect activation of proliferation in the bone marrow erythroid stem. Similar changes developed in group 2 animals during the same period.

The results of experiments with group 1 animals are consistent with published data that vibration exposure inhibits erythropoiesis, decreases mitotic activity of bone marrow cells, and increases the incidence of mitotic aberrations [1,5]. The changes revealed in patients with vibration disease illustrate failure of compensatory mechanisms [10].

The development of similar changes in peripheral blood red cells from group 2 animals suggests that bioactive substances constituting *Glycyrrhiza glabra L.* (triterpene saponins, flavonoids, polysaccharides, pectins, amino acids, mineral salts, *etc.*) modulate metabolism and accelerate maturation of cells in the bone marrow erythroid stem. It results in activation of the sympathetic mechanisms for erythropoiesis and provides relatively high level of the erythrocyte balance. Published data show that liquid licorice extract produced an adaptive effect manifesting in recovery of blood glucose concentration during hypoxia [2].

Bioactive substances of *Glycyrrhiza glabra L.* roots protect the organism from adverse effects of continuous vibration, enhance compensatory reserve, and increase the resistance to stress. Our results are consistent with published data that vibration exposure for 30 days increases malonic dialdehyde (MDA) concentration in blood plasma, liver, and myocardium [7]. Consumption of licorice roots with food is accompanied by a decrease in MDA concentration and increase in antioxidant activity of blood plasma. These changes illustrate a decrease in the stress effect of vibration.

Our results indicate that licorice root holds much promise as a preventive medicine reducing the severity of stress-induced changes and improving organism's resistance to extreme factors (*e.g.*, vibration).

REFERENCES

1. G. A. Alekseev and V. M. Pogorelov, *Med. Truda Prom. Ekol.*, No. 5, 27-30 (1995).
2. G. N. Bezdetko, P. S. Zorikov, and E. N. Shatokhin, *New Biomedical Technologies with Biologically Active Additives* [in Russian], Moscow (1998), pp. 50-53.
3. V. A. Bykov, K. G. Zapesochnaya, V. A. Korkin, *et al.*, *Human and Medicines* [in Russian], Moscow (1996), p. 12.
4. A. A. Lantsov and A. N. Pashchinin, *Vestn. Otorinolaringol.*, No. 2, 25-29 (1993).
5. P. N. Lyubchenko, L. I. Kovalev, R. V. Gorenkov, *et al.*, *Med. Truda Prom. Ekol.*, No. 12, 11-14 (1996).
6. M. M. Mel'nikova, *Ibid.*, No. 5, 36-42 (1995).
7. K. R. Oganisyan, G. A. Pogosyan, A. O. Oganisyan, *et al.*, *Vestn. Mezhdunar. Akad. Nauk Ekologii Bezopasnosti*, **7**, No. 6, 199-202 (2002).
8. E. F. Stepanova and A. M. Sampiev, *Khim. Farm. Zh.*, **31**, No. 10, 39-43 (1997).
9. A. D. Turova, E. N. Sapozhnikova, and V'en Dyok Li, *Medicinal Plants in USSR and Vietnam* [in Russian], Moscow (1987).
10. L. A. Shpagina, M. I. Loseva, and T. M. Sukharevskaya, *Med. Truda Prom. Ekol.*, No. 4, 30-32 (1990).
11. V. Ya. Shustov, A. D. Trubetskov, R. V. Kalashnikov, *et al.*, *Ibid.*, No. 3, 31-34 (1996).