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CORRECTIVE EFFECT OF NAKED LICORICE (*GLYCYRRHIZA GLABRA* L.) ON BLOOD PARAMETER SHIFTS UNDER NOISE EXPOSURE

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It was observed that a 30-day exposure to noise resulted in significant decreases in the total number of erythrocytes, reticulocytes, and hemoglobin levels, along with a marked reduction in blood oxygen capacity. In contrast, the 30-day combined exposure to noise and licorice root (*Glycyrrhiza glabra* L.) led to a significant increase in these hematological parameters, thereby promoting homeostasis under conditions of prolonged exposure to noise as a stress factor.

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***Keywords*:** blood, noise, licorice root.

Introduction. Noise pollution has emerged as one of the most prevalent professional pathologies of contemporary society. It is a consequence of both adverse ecological conditions and the escalating technogenic impact on human health. Chronic exposure to noise leads to premature fatigue, diminished productivity, and, in situations of prolonged exposure, can induce profound and irreversible physiological changes. This condition, often referred to as “noise disease,” ranks among the leading causes of occupational illnesses globally [1, 2]. Noise exposure is deceptive, individuals may perceive themselves as having acclimated to it, yet continuous acoustic pollution undermines human health, instigating various pathological changes. Notably, noise affects not only specific organs, but also exerts systemic repercussions on multiple bodily systems. The central nervous system, cardiovascular system [3, 4], and digestive tract are particularly susceptible. For instance, sustained exposure to intense noise (≥ 80 *dB*) has been associated with disorders such as gastritis and peptic ulcer disease due to impairment of gastric secretory and motor functions. Compounded effects include altered heart rates, elevated blood pressure [5, 6], and compromised cerebral perfusion. Urban noise has also been implicated in the etiology of hypertension [5, 7] and ischemic heart disease [6, 7].

Moreover, noise exposure accelerates respiratory rates, diminishes attentional capacities, and reduces both physical and mental performance. The detrimental effects extend to visual and vestibular apparatuses, resulting in decreased visual

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acuity and compromised reflex stability [5]. The perpetual irritability and anxiety induced by noise can disrupt normal rest and recovery, interfere with sleep, and ultimately diminish work capacity. Chronic noise exposure can further alter redox processes within the body, which are vital for maintaining physiological resistance, and is hypothesized to be a risk factor for certain cancers [4, 8]. Thus, it is evident that noise exerts a deleterious and pervasive influence on human health. Addressing the adverse impacts of noise is an urgent mandate for preventive medicine and biology. Efforts to mitigate disturbances resulting from anthropogenic factors must focus on identifying effective means to bolster the body resilience. Herbal preparations have proven invaluable in treating and preventing adverse physiological phenomena arising from environmental stressors [9]. These natural remedies are distinguished by their complex, multifaceted effects, which include a spectrum of bioactive compounds that exert general strengthening and tonic effects. Moreover, they are associated with fewer side effects and lower toxicity, while promoting homeostasis by enhancing metabolic processes in the body [9, 10].

The pharmacological properties of many plant-derived bioactive substances closely mimic natural metabolites in humans, ensuring compatibility and necessity for maintaining normal life. Achieving optimal concentrations of exogenous antioxidants is crucial for sustaining homeostasis and cultivating the bodys tolerance to various detrimental influences. Among the myriad of plant-based compounds known for their regulatory effects in stressful contexts, naked licorice root (*Glycyrrhiza glabra* L.) has garnered attention for its therapeutic efficacy, particularly in traditional medicine [10–12]. Licorice has been shown to possess a range of pharmacological properties, including anti-stress, analgesic, adaptogenic, anti-inflammatory, antitoxic, antiulcer, antiallergic, antitumor, hepatoprotective, immunotropic, antiviral, hypolipidemic, and antioxidant activities [9, 13–16]. Historically, Chinese practitioners incorporated licorice extract into numerous formulations, recognizing its capacity to enhance the efficacy of other medicinal components. Given its abundant availability, licorice has emerged as a widely utilized raw material in modern herbal medicine. The structural similarity of glycyrrhetic acid to adrenal cortex hormones underlies its mineralocorticoid and glucocorticoid activity [17]. The sweet taste of licorice roots is attributed to glycyrrhizin, which is approximately 150 times sweeter than sucrose [9, 13].

In the past century, numerous bioactive complexes have been isolated from licorice, alongside hundreds of individual compounds classified into various chemical categories, each demonstrating diverse pharmacotherapeutic properties [17]. Notably, one of licorice most prominent pharmacological attributes is its marked anti-inflammatory effect, which inhibits inflammatory reactions mediated by histamine, serotonin, and bradykinin.

In traditional medicine, licorice is utilized both as a standalone treatment and as a component of various multi-ingredient formulations, including diuretics, diaphoretics, expectorants, analgesics, antiseptics, and tonics targeted at conditions affecting the lungs, digestive system, kidneys, and beyond [13, 15]. Furthermore, licorice is employed to enhance the non-specific resistance of immunocompromised individuals [9].

When administered *in vivo*, licorice preparations function as effective antioxidants, countering the detrimental consequences associated with lipid peroxidation processes [11, 14, 16]. The anti-inflammatory and antioxidant capabilities of licorice roots are well-documented through empirical studies. Against this backdrop, the present study aims to investigate the alterations in red peripheral blood indices among rabbits subjected to 30 days of noise exposure and to evaluate the reporative role of licorice in bolstering resistance to noise-induced stress.

Materials and Methods. The experimental study involved 18 sexually mature male Chinchilla rabbits, each weighing between 2.0–2.5 *kg*. The rabbits were subjected to a controlled noise environment, exposed to stable noise at a frequency of 1000 *Hz* and an intensity of 114 *dB*, generated by a NG-34 sound generator. The duration of noise exposure lasted for 30 days, with sessions conducted for 2 *h* each day.

A separate group of rabbits received environmentally friendly Armenian licorice root (*Glycyrrhiza glabra* L.), sourced from Manufacturer "Antaram" in Gavar, Tsovazard, Armenia (License No. RA 1264). The licorice was administered at a dosage of 150 *mg* per 100 *g* of body weight, daily, for a duration of 20 days.

To account for diurnal and seasonal variations in physiological functions and biochemical parameters, all experiments were conducted consistently at 9:00 a.m. during the November to March timeframe. The experimental animals were stratified into three distinct groups:

– I Group: Exposed to noise for 30 days.

– II Group: Administered licorice root for 20 days.

– III Group: Received combined treatment of noise exposure and licorice root for 30 days.

The animals weight, behavior, and fur condition were monitored throughout the study to assess general health and wellbeing.

Blood analyses were performed at baseline and every 5 to 10 days during the noise exposure and licorice administration periods. The analyses included the enumeration of erythrocytes, measurement of hemoglobin concentration, calculation of the color index, and determination of both relative and absolute reticulocyte counts. The oxygen-carrying capacity of the blood (OCB) was also calculated, employing the Hufner coefficient (1.34–1.39 *mL* O_2 per *g* of hemoglobin).

The relative percentage of reticulocytes was quantified using the Egorov method, from which the absolute count was subsequently derived. The experiments adhered to the ethical principles outlined in the Helsinki Declaration regarding the humane treatment of animals [18, 19]. Statistical analysis of the obtained data was conducted using the Student's *t*-test to assess the significance of differences between the studied parameters under normal conditions and in response to noise exposure and licorice treatment.

Results and Discussion. Analysis of the collected data revealed significant changes starting from the 10^{th} day of noise exposure in I Group, including a marked decrease in the absolute number of erythrocytes and hemoglobin concentration compared to baseline measurements (Tab. 1). Specifically, the number of erythrocytes decreased by 10.7%, 12.5%, and 34.1% on days 10, 20, and 30, respectively. Similarly, hemoglobin levels dropped by 12.6%, 11.7%, and 22.6% over the same periods.

The most pronounced decrease was recorded on the 30th day, indicating a suppression of erythropoiesis. However, a consistent increase in both relative and absolute reticulocyte counts was observed during this period, except notably on the 30th day. These changes suggest activation of the release of immature erythrocytes from the bone marrow into circulation, likely reflecting a compensatory mechanism.

The alterations noted in these hematological indices appear to correlate with suppressed adrenal function due to prolonged noise exposure [20]. This is evidenced by decreased levels of 11-oxygenated corticosteroids (11-OCS), adrenaline, noradrenaline, and a reduction in both eosinophil and peripheral blood lymphocyte counts, alongside an increase in adrenal gland mass. Such changes in leukocyte profiles and adrenal morphology were similarly observed in this study.

Rabbits in II Group, fed licorice root for 20 days, demonstrated a gradual normochromic increase in erythrocyte counts, hemoglobin levels, and reticulocyte counts. The peak increases were observed on the 20th day, surpassing baseline values by 11.9%, 5.8%, and 36.0%, respectively (Tab. 1).

Table 1

Changes in red peripheral blood indices in rabbits under the influence of noise exposure and licorice treatment

Days of experience	Researched indicators				
	number of erythrocytes in 1 mm^3 of blood (in millions)	hemoglobin content in gram %	color index	relative number of reticulocytes ‰	absolute number of reticulocytes in 1 mm^3 of blood (in millions)
I Group					
Indicators before the experiment	5.42±0.32	11.9±0.4	1.10	15.9±0.4	8617.8±593.6
10	4.84±0.21	10.4±0.17	1.29	25.0±0.6***	12100.0±639.4*
20	4.74±0.16*	10.5±0.02	1.11	20.66±0.9**	9792.84±590.1*
30	3.57±0.12**	9.2±0.36*	1.32	14.0±0.4*	4998.0±250.8***
II Group					
Indicators before the experiment	4.94±0.15	13.6±0.1	1.38	15.0±0.3	7410.0±290.6
10	5.49±0.09*	15.1±0.4*	1.39	15.3±0.4	8399.7±351.2
20	5.53±0.32	14.4±0.8	1.30	20.5±0.6***	11336.5±493.3***
III Group					
Indicators before the experiment	5.01±0.16	13.6±0.1	1.36	13.3±0.5	6663.3±411.1
10	4.96±0.01**	11.8±0.2***	1.20	15.0±0.3	7440.0±0.02
20	4.51±0.22**	13.3±0.3***	1.47	20.0±0.4**	9020.0±237.5
30	5.14±0.36**	14.5±0.2***	1.41	23.7±0.6	12181.8±445.7**

Note: * $p < 0.05–0.02$; ** $p < 0.01$; *** $p < 0.001$.

Erythroid cells undergo both structural and metabolic transformations throughout their development. These nuclear erythroid cells are capable of various metabolic reactions characteristic of tissue cells. Notably, they engage in active

nucleic acid exchange, which facilitates their capacity for proliferation. Metabolic activity in reticulocytes occurs via both aerobic and anaerobic pathways, while normocytes predominantly rely on anaerobic metabolism.

During stress conditions developing in hypoxic tissues, the oxygen demands of erythroid cells may briefly be met through anaerobic glycolysis. However, the energy generated from these limited resources is insufficient for prolonged periods. This metabolic strain is exacerbated by an increased requirement for glucose, which is typically unmet over extended durations.

It is suggested that the mono- and disaccharides (up to 20%) present in licorice roots, along with water-soluble polysaccharides [14, 17], play a compensatory role in meeting tissue demands for these critical substrates, subsequently stimulating both aerobic and anaerobic metabolism and enhancing energy supply for erythroid cells in the bone marrow.

The consistent directional shifts in peripheral blood indices observed among rabbits receiving 20 days of licorice treatment imply that corticosteroid-like compounds within licorice may modulate intracellular metabolic processes in erythroid cells. This modulation likely facilitates the differentiation and maturation of cellular forms, resulting in elevated levels of erythrocytes and reticulocytes in circulation compared to initial data.

In III Group, where rabbits were subjected to 30 days of combined noise exposure and licorice treatment, a moderate decline in erythrocyte counts persisted through day 20.

However, by day 30, these parameters notably exceeded baseline measurements. Moreover, relative and absolute reticulocyte counts showed increases throughout the study: 12.7% on day 10, 50.3% on day 20, and 78.1% on day 30. These findings indicate enhanced proliferation and maturation of erythroid cells within the bone marrow, consistent with the observed shifts in peripheral blood indices (Tab. 2) [21, 22].

Table 2

Changes in oxygen-carrying capacity of rabbit blood under the influence of noise and licorice roots

Days of the experiment	Animal groups		
	I	II	III
Indicators before the experiment	15.94	14.94	18.22
10	13.93	20.23	15.81
20	14.07	19.29	17.82
30	12.32	–	19.43

Consequently, the data suggest that the bioactive compounds in naked licorice significantly enhance the metabolic activity and energy supply of erythroid cells in the bone marrow, thereby promoting cellular proliferation and maturation while improving the overall composition of red blood parameters under chronic noise exposure.

Furthermore, the changes in the activity of succinate dehydrogenase (SDH) observed in this study reflect alterations in redox processes within tissues. The role

of the SDH system in biological oxidation is essential, particularly under conditions of mechanical stress. The SDH enzyme, closely associated with mitochondrial membranes, can monopolize the respiratory chain under challenging conditions, serving a critical compensatory role in cellular energy supply [23].

It is pertinent to note that naked licorice exhibits structural similarities to corticosteroid hormones due to the presence of glycyrrhizin, which is hydrolyzed to glycyrrhizic acid [13, 15]. The latter undergoes metabolic transformations in the organism that elicit corticosteroid-like effects. The documented increase in erythroncytosis among animals treated with licorice aligns with existing literature, indicating stimulation of bone marrow hematopoiesis by glucocorticoids, specifically corticosterone [21, 22, 24].

The beneficial impact of licorice preparations on experimental subjects can also be attributed to the presence of other pharmacologically active constituents. These include flavonoid glycosides such as liquiritin, liquiritigenin, and liquiritoside, as well as pectin, proteins, sucrose, glucose, bitter and resinous compounds, starch, asparagine, vitamins (particularly ascorbic acid), pigments, essential oils, and various other bioactive substances [3, 17].

In summary, it can be concluded that naked licorice (*Glycyrrhiza glabra* L.) exerts a corticosteroid-like effect, stimulating red bone marrow function. Its antioxidant properties contribute positively to overall health, enhancing the resilience and physiological activity of animals subjected to noise-related stress.

Theoretical and Practical Significance. The findings of this study possess both theoretical and practical implications in the fields of medicine and labor physiology. The results may serve as a foundation for clinical applications focused on treating occupational pathologies linked to noise exposure.

Furthermore, the evidence supports the recommendation of licorice as an effective anti-stress agent aimed at augmenting the body resistance to noise, as the biologically active compounds contained in licorice appear to mitigate the deleterious effects of noise on physiological systems, thereby expanding the adaptive and compensatory capacities of the body.

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REFERENCES

1. Babanov S.A., et al. *Occupational Diseases*. Publishing group GEOTAR-Media (2021), 592 (in Russian).
2. Fisun A., Khalimov Yu., et al. *Occupational Disease* (*textbook on medicine*). St-Pb., Foliant (2019), 592 (in Russian).
3. Nekipelov M.N. *Effect of Combined Action of Noise and Psychological Stress on Performance and Health of Students. Chemistry and Health.* Abstract of Plenary Report of Scientific Session and Regional Conf. “Problems of Medical Ecology and Human Health in Siberia”. Irkutsk (1996), 26 (in Russian).
4. Rebentisch E., Lange-Asschenfeldt H., Ising H. Gesundheitsgefahren Durch Lärm. *BGA-Schrifte*. **1** (1994), 1–114.
5. Tsaneva L., Balychev Yu. Assessment of the Impact of Some Noise Indicators on Humans. *Vestn. otolaryngol. J.* (1995), 55 (in Russian).

6. Jovanovic J., Popovic V., Milosevic Z. Cumulative Effects of Communal and Industrial Noise on Cardiovascular System. *Fakta Univ. Ser. Med. and Biol., Univ. Nis*. **4** (1997), 57–61.
7. Yazburekis B.I., Karpinskaya T.V. *Prevalence of Non-occupational Diseases Among Workers in Conditions of Noise, Vibration and Ultrasound*. Actual. Issues of Prof. Diseases: Clinic, Diagnostics, Treatment. Moscow (1995), 96–100 (in Russian).
8. Kulkybaev G.A., Ismailova A.A. Evaluation of the Psychological Status of Miners Exposed to Noise. *Hygiene and Sanittion J*. **3** (2003), 29–32 (in Russian).
9. N*ational Formulary on Herbal Medicines*. Yerevan (2001), 119.
10. Bhandari S., Ojha N. Therapeutic Effects of *Glycyrrhiza glabra* Linn. *Intern. J. Ayurveda and Pharma Research* (2023), 39–49. https://doi.org/10.47070/ijapr.v11i11.2910
11. Kazlauskaite J.A., et al. Application of Antiviral, Antioxidant and Antibacterial *Glycyrrhiza glabra* L., *Trifolium pratense* L. Extracts and *Myristica fragrans* Houtt. Essential Oil in Microcapsules. *Pharmaceutics* **15** (2023), 464. https://doi.org/10.3390/pharmaceutics15020464
12. Batiha El-Saber G., Beshbishy A.M., et al. Traditional Uses, Bioactive Chemical Constituents and Pharmacological and Toxicological Activities of *Glycyrrhiza glabra* L. (Fabaceae). *Biomolecules* **10** (2020), 352. https://doi.org/10.3390/biom10030352
13. Bondarev A.I., Zarudiy F.S., Rusakov I.A. Solodka (Review). *Chemic.-Pharm. J*. **29** (1995), 33–39 (in Russian).
14. Palagina M.V., Dubnyak N.S., et al. Correction of the Respiratory Organ Impairment with Ural Licorice Preparation in Chronic Skin Diseases. *Ter. Arch. J*. **1** (2003), 63–65 (in Russian).
15. Stepanova E.F., Sampiev A.M. The State of Research and Prospects for the Use of Licorice Herb. *Chem. Pharm. Jour*. **31** (1997), 39–43 (in Russian).
16. Shetty T.K., Satav J.G., Nair C.K. Protection of DNA and Microsomal Membranes *in vitro* by *Glycyrrhiza glabra* L. against Gamma Irradiation. *Phytother. Res.* **16** (2002), 576–578. https://doi.org/10.1002/ptr.927
17. Obolentseva G.V., Litvienko V.I., et al. Pharmacological and Therapeutic Properties of Licorice Preparations (Review). *Chemic.-Pharm. J*. **8** (1999), 24–31(in Russian).
18. Kuflina S.A., Pavlova T.N. *Euthanasia of Experimental Animals. Method of Recommendation*. Moscow (1985) (in Russian).
19. World Medical Association Declaration of Helsinki: Ethical Principles for Medical. *Research Involving Human Subjects. IJMS* (2002), 42–46.
20. Khukhrina L.A., Kadyskina E.N. II All-Union. Conf. “The Endocrine System of the Body and Harmful Environmental Factors”. Abstracts of Reports. Leningrad (1983), 208 (in Russian).
21. *Pathophysiology of the Blood System.* Study guide (3rd ed. by prof. G.V. Poryadin). Moscow (2012), 57 (in Russian).
22. Smirnova O.V., Sirotina N.S. *Physiology and Pathophysiology of the Endocrine System*. Publ. Society of Scientific Publications KMK (2024), 353 (in Russian).
23. Oganesyan A.O., Oganesyan K.R., et al. Effect of Corice on the Activity of Succinate Dehydrogenase when Exposed to Vibration. *Hygiene and Sanitation J.* **4** (2006), 76–77.
24. Vismont F.I., Kasap V.A., et al. *Pathophysiology of the Blood System. Study Guide.* Minsk (2002), 91 (in Russian).

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ՔԱՂՑՐԱՐՄԱՏԻ (*GLYCYRRHIZA GLABRA* L.) ՇՏԿՈՂ ԱԶԴԵՑՈՒԹՅՈՒՆԸ ԱՐՅԱՆ ՑՈՒՑԱՆԻՇՆԵՐԻ ՓՈՓՈԽՈՒԹՅԱՆ ՎՐԱ ԱՂՄՈՒԿԻ ՊԱՅՄԱՆՆԵՐՈՒՄ

30-օրյա աղմուկի ազդեցությունից դիտվել է ճագարների շրջանառու արյան էրիթրոցիտների, ռեթիկուլոցիտների քանակի, հեմոգլոբինի պարունակության, արյան թթվածնային տարողության զգալի նվազում: Սակայն

աղմուկի և մատուտակի արմատի (*Glycyrrhiza glabra* L.) 30-օրյա համակցված ազդեցությունը հանգեցրել է այս արյունաբանական ցուցանիշների զգալի աճի, այդպիսով խթանելով դրանց հոմեոստազը աղմուկի՝ որպես սթրեսային գործոնի, երկարատև ազդեցության պայմաններում:

Э. С. ГЕВОРКЯН, К. Р. ОГАНЕСЯН

КОРРЕКТИРУЮЩЕЕ ДЕЙСТВИЕ СОЛОДКИ ГОЛОЙ (*GLYCYRRHIZA GLABRA* L.) НА ИЗМЕНЕНИЯ ПАРАМЕТРОВ КРОВИ ПРИ ВОЗДЕЙСТВИИ ШУМА

Было отмечено, что 30-дневное воздействие шума приводило к значительному снижению общего количества эритроцитов, ретикулоцитов и уровня гемоглобина, а также к выраженному снижению кислородной емкости крови. Напротив, 30-дневное комбинированное воздействие шума и корня солодки (*Glycyrrhiza glabra* L.) приводило к значительному повышению этих гематологических показателей, способствуя тем самым поддержанию гомеостаза в условиях длительного воздействия шума как стресс-фактора.