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Effect of Physical Training on Blood Volume, Hemoglobin, Alkali Reserve and Osmotic Resistance of Erythrocytes.*

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That previously confined dogs when exercised for a few days undergo a loss of blood volume erythrocytes and hemoglobin has been shown by Broun.[1, 2] This loss he attributes to a process of fragmentation which other workers[3] have advocated as a normal mode of erythrocyte destruction. Thörner[4, 5] has reported an increase in the osmotic resistance of erythrocytes of man and dog after a period of training. This he explains by a "weeding out" through mechanical fragmentation of less resistant corpuscles. Hastings[6] has shown that *in vivo* hemolysis occurs in the serum of untrained dogs after exercise. Broun's dogs showed recovery of hemoglobin and erythrocytes with continued training and of blood volume after 3 weeks' rest. Anoxemia by anemia has been suggested as the bone marrow stimulant in the recovery process, by Steinhaus.[7]

The present work was undertaken to determine whether or not prolonged physical training will induce an increase of blood volume and erythrocytes, and if possible, to throw light on the hematopoietic stimulant as well as the mode of blood destruction in exercise.

Five dogs were confined for 2 or 3 months without exercise and were then exercised for 2 hours daily over periods of 4 to 9 weeks' duration. Observations on the blood were made throughout this time and continued for a few weeks after exercise was stopped. Two dogs swam in water at 30°C. for 2 hours and 3 ran on a treadmill set at 25% grade for a distance of 6 miles, daily. A constant mixed diet including 200 gm. of beef liver was fed daily beginning a month before control observations began and continuing throughout the exercise and post-exercise period. During the training period dogs were fed after the day's exercise.

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1 Broun, G. O., *J. Exp. Med.*, 1923, **37**, 207.

2 Broun, G. O., *J. Exp. Med.*, 1923, **37**, 187.

3 Rous, P., and Robertson, O. H., *J. Exp. Med.*, 1917, **25**, 651.

4 Thörner, W., *Arbeitsphysiol.*, 1929, **2**, 116.

5 Thörner, W., *Arbeitsphysiol.*, 1932, **5**, 516.

6 Hastings, A. B., *U. S. P. H. Bulletin*, **1921, 117, 17.**

7 Steinhaus, A. H., *Physiol. Rev.*, 1933, **13**, 119.

All blood determinations were made under basal conditions of the animal at least 18 hours after previous exercise and food. Blood volume was measured by carbon monoxide inhalation method[8] using the blood gas manometric method of Van Slyke and Neill.[9] Hemoglobin was determined by the method of Palmer,[10] and alkali reserve was calculated as plasma bicarbonate using the CO_2 method of Van Slyke.[9] We used Hastings'[6] method for the measurement of erythrocyte osmotic resistance.

An increase in alkali reserve was finally obtained in all 4 dogs used for this test. Increased alkali reserve in training has been observed in man,[11] but not to our knowledge, heretofore, in dogs.

The osmotic resistance of erythrocytes increased significantly in the 2 swimming dogs, although 1 dog did not show any change after one week of training. Dog No. 5, a treadmill runner, used only for this test, showed a small decrease in R.B.C. resistance accompanied in the first week of training by a reduction of 15% in hemoglobin per unit volume of blood.

Blood volume, total cell volume, and erythrocyte count, with one exception, were sharply reduced in the first week, but in spite of continued exercise recovered to and exceeded the normal levels. These elevated values were observed in both running and swimming dogs and persisted usually for about a month after cessation of exercise.

Similarly, hemoglobin per unit volume of blood was at first sharply reduced by exercise, but recovered irregularly and did not in any case significantly exceed the normal level.

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[8] Chang, H. C., and Harrop, G. A., *J. Clin. Invest.*, 1928, **5**, 393.

[9] Van Slyke, D. D., and Neill, J. J., *J. Biol. Chem.*, 1924, **61**, 523.

[10] Palmer, W. W., *J. Biol. Chem.*, 1918, **33**, 119.

[11] Walinski, *Veröffentl. a. d. geb. d. Heeressanitätswesens*, 1925, **78**, 37.