

**EFFECTS OF ELEUTHEROCOCCUS SENTICOSUS MAXIM. ON PHYSICAL PERFORMANCE AND RESOURCES IN MAXIMAL AND SUBMAXIMAL WORK**

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**Introduction**

The principle action of *Eleutherococcus* has been postulated on its power to increase the resistance of the organism to general stress including physical work. It has been shown that animals became more resistant to muscular work, overload in various stress conditions (Brekhman, 1965; 1968; Brekhman, Kirillov, 1968; Kirillov, 1966). Gordeicheva et al. (1975) reported an effectiveness for increasing physical performance in man by using *Eleutherococcus* extract (8 ml/day for 15 days).

However, only few information is available to elucidate the function of *Eleutherococcus* to maximal and submaximal physical working capacity. The purpose of this study is to investigate the influence of *Eleutherococcus* on physical performance and resources in maximal and submaximal work.

**Subjects and Methods**

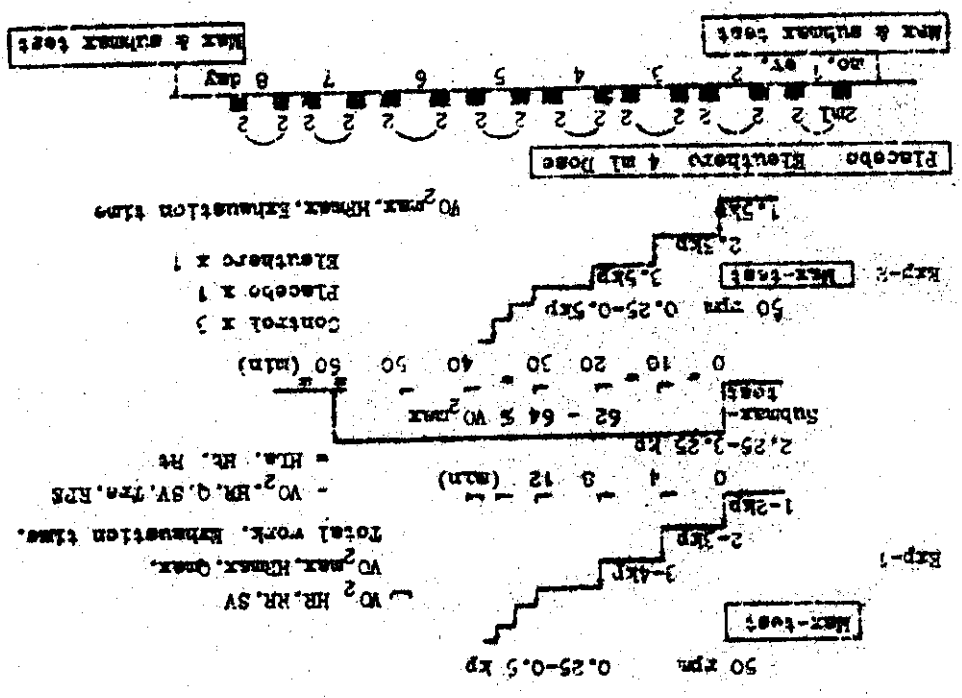
Two series of experiments were performed.

1) Experiment 1: Effects of *Eleutherococcus* extract (EE), 4 ml/day during 8 days, on maximal and submaximal prolonged working capacity.

Subjects were 6 male healthy students aged 21-23 (mean: 22.2 yrs.) who were taking part in sport activities of baseball and Judo. Their ages, physical characteristics and aerobic capacities are presented in Table 1.

The maximal and submaximal prolonged work tests were performed before and after dosing. Fluid EE (2 ml 30 min before breakfast and dinner, respectively) was taken during 8 days. This experimental protocol is presented in Fig. 1.

Prior to the 60 min prolonged work test, the maximal oxygen uptake ( $\dot{V}O_2$  max), maximal heart rate (HR max), maximal cardiac output (Q max), maximal total work, and exhaustion time of the subjects were determined by using a 12 min stepwise increasing



Subj	Age (yrs)	Sports	Height (cm)	Weight (kg)	Chest G. (cm)	S.P.P. (cm)	Subcap Arterio Abdom. (%)	Fat (%)	VO <sub>2</sub> max (ml/kg/min)	post	
A.E.	22	baseball	173.1	73.2	91.5	9.5	8.5	14.0	12.7	51.8	45.1
I.H.	22	"	176.9	77.0	93.5	14.5	12.5	19.0	16.9	40.4	38.3
M.T.	22	"	172.0	68.4	90.1	10.5	12.0	17.5	14.8	40.1	46.3
K.L.	22	"	176.1	69.2	92.8	9.0	6.5	12.0	11.6	45.6	45.9
K.K.	22	Judo	174.8	72.1	98.0	10.0	9.0	15.0	13.2	48.0	48.6
M.C.	23	"	176.2	83.0	100.0	9.5	6.0	6.0	11.5	44.0	42.1
X	22.2		174.9	73.8	94.3	10.5	9.1	13.9	13.5	45.0	44.0
SD	0.4		1.8	5.0	3.5	1.8	2.5	4.2	1.9	4.1	3.3

Physical characteristics and work capacity in subjects (Exp. 1)

submaximal and maximal bicycle ergometer.

This  $\dot{V}O_2$  max was used for calculating the relative intensity of subsequent prolonged work. The prolonged work was performed on a Monark ergometer (50-rpm) for 60 min at a constant workload of 62-64 % of  $\dot{V}O_2$  max.

Respiro-circulatory responses, including heart rate (HR), oxygen uptake ( $\dot{V}O_2$ ), cardiac output ( $\dot{Q}$ ), rate of perceived exertion (RPE), and rectal temperature were measured every 10 min during work. Blood lactate concentration (HLs) was determined at rest, after 5, 15, 35, and 60 min of work and 5 min of recovery.

$\dot{V}O_2$  was determined with the Douglas bag method and the gas fractions of  $O_2$  and  $CO_2$  were measured with a Beckman OM-11 and LB-2 checked by the Scholander volumetric analyzer. For the measurement of stroke volume (SV), impedance cardiograms by using IEM MINISOZA impedance cardiograph (Model 400) were recorded at rest and every 10 min during work.

2) Experiment 2: Effects of ES and placebo (4 ml/day during 8 days) on maximal working capacity.

Subjects were 6 male healthy students aged 21-22 (mean: 21.5 yrs.) who were taking part in sport activities of baseball. Their ages, physical characteristics and aerobic capacities are presented in Table 2.

Prior to the ES and placebo dosing tests, maximal pedalling work test was conducted 3 times as control experiment, successively. Thereafter, maximal aerobic capacity test was administered before and after placebo and ES dosing during 8 days. It included the maximal oxygen uptake ( $\dot{V}O_2$  max), maximal heart rate (HR max), maximal total work and exhausting time (Fig. 1).

#### Results and Discussion

1) Effects of ES dosing on maximal and sub maximal prolonged work capacity.

##### Maximal working capacity.

The exhaustive pedalling time increased significantly from  $16.8 \pm 1.9$  min to  $18.6 \pm 1.7$  min (10.7 %) after dosing ( $P < 0.001$ ) and maximal total work increased significantly from  $15.6 \times 10^3 \pm 2.5$  kpm to  $18.4 \times 10^3 \pm 2.7$  (17.9 %) after dosing ( $P < 0.001$ ). However,  $\dot{V}O_2$  max and  $\dot{Q}$  max did not show significant increase (Fig. 2).

From these results, it would be suggested that maximal physi-

Table 2  
Physical characteristics and work capacity in subjects (Exp. 2)

Subj. Age (male) (yrs)	Sports	Height (cm)	$C_1$	$C_2$	$C_3$	$\dot{V}O_2$ max (ml/kg/min)	$\dot{V}O_2$ max (ml/kg/min)
H.S. 21	baseball	168.0	72.6	72.0	72.0	71.6	72.3
T.K. 21	"	172.0	70.6	71.2	71.6	71.9	72.6
Y.C. 21	"	167.0	64.3	64.4	64.1	63.8	64.1
M.C. 22	"	170.0	66.2	66.5	66.5	66.6	66.8
Y.I. 22	"	164.0	59.4	59.1	58.1	58.5	58.5
Y.F. 22	"	156.0	65.8	67.5	67.7	67.2	67.2
M 21.5		167.8	66.5	66.8	66.7	66.6	66.7
S.D. 0.5		2.6	4.3	4.3	4.7	4.6	4.8
Control ( $C_1$ , $C_2$ , $C_3$ , placebo (P), Methylococcus (K))							
		17.0	7.5	15.8	45.4	48.5	48.6
		10.0	9.0	13.2	46.4	48.5	48.5
		9.0	5.0	10.9	43.9	51.7	51.7
		9.5	5.0	11.1	48.2	54.0	54.0
		9.0	5.0	10.9	49.2	55.5	55.5
		11.0	7.0	12.7	47.4	54.4	54.4
		10.9	6.4	12.4	46.8	52.1	52.1
		2.8	1.5	1.8	1.8	2.8	2.8

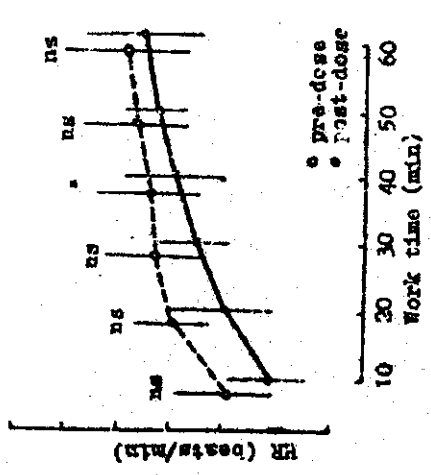


FIG. 3

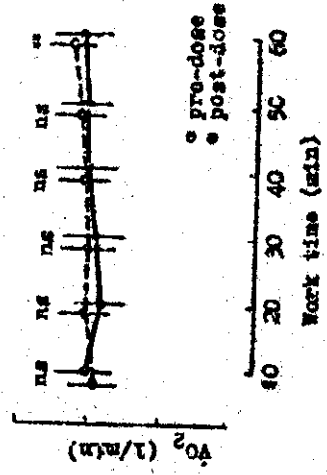


FIG. 4

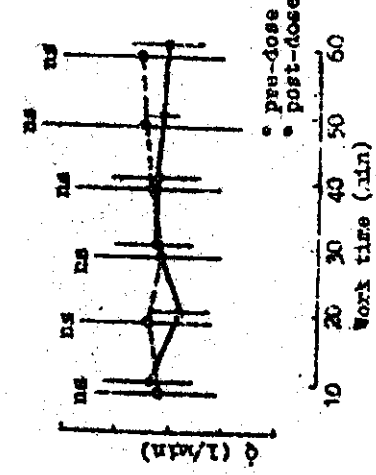


FIG. 5

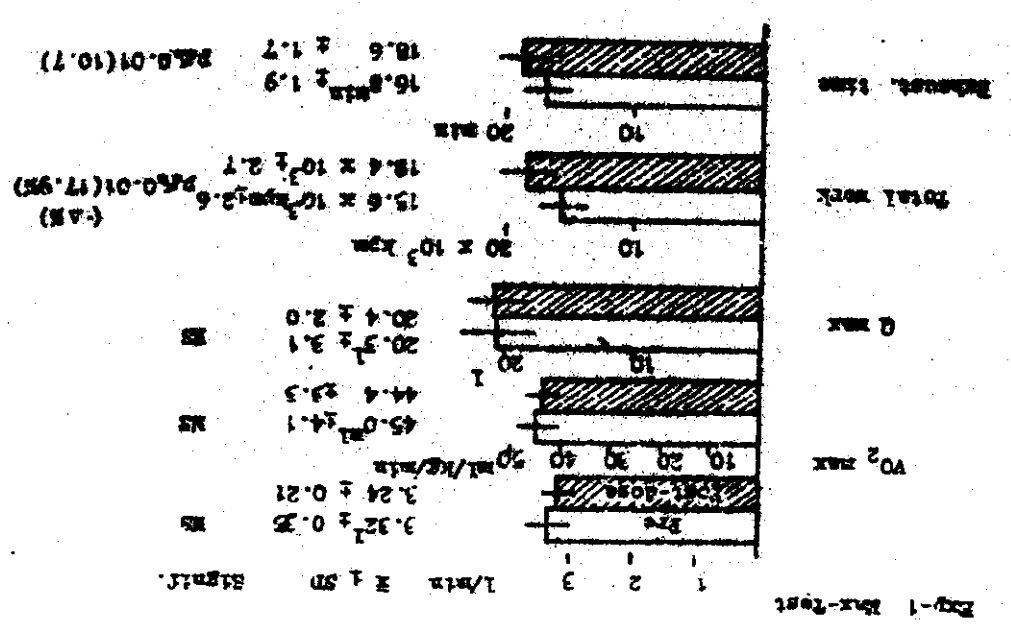


Fig-2

cal performance such as exhaustion time and maximal total work could be improved by EE dosing for 8 days, while the improvement in maximal physical resources such as  $\dot{V}O_2$  max and  $\dot{Q}$  max could not show any significant difference.

Submaximal prolonged work:

HR before and after EE dosing showed a progressive increase during work. In general, however, there is a lower tendency (5-10 beats) in HR during work after dosing than that of before dosing (Fig. 3).  $\dot{V}O_2$  before and after EE dosing showed almost constant values during work. However, after dosing test, there is a significant decrease (3.2 %,  $P < 0.05$ ) at 60 min work (Fig. 4).  $\dot{Q}$  before and after dosing showed almost constant values during work. In general, there is a lower tendency after dosing than that of before dosing (Fig. 5).

RPE before and after dosing showed a progressive increase during work. In general, there is a lower tendency (0.5-1.5) in RPE during work after dosing than that of before dosing (Fig. 6).

Rectal temperature before and after dosing also showed a progressive increase during work and rose from  $37.4^\circ\text{C}$  after 10 min to  $38.8^\circ\text{C}$  after 60 min. However, there is a lower tendency ( $0.2-0.3^\circ\text{C}$ ) in rectal temperature during work after dosing than that of before dosing (Fig. 7).

H<sub>1a</sub> before and after dosing showed a progressive increase until 15 min during work and thereafter showed a progressive decrease. In general, there is a lower tendency ( $0.4-0.7$  ml/l) in H<sub>1a</sub> at rest and during work after dosing than that of before dosing (Fig. 8).

From these results, it would be suggested that an improvement for metabolism of less glycolytic and efficient oxygen-transporting function during prolonged submaximal work might be brought by successive 8-day EE dosing.

2) Effects of EE and placebo dosing on maximal working capacity (Fig. 9).

$\dot{V}O_2$  max after EE dosing increased significantly by 11.9 % ( $P < 0.01$ ) comparing 5.8 % increase after placebo dosing.

The maximal oxygen pulse ( $O_2$  pulse max) after EE dosing increased significantly by 7.9 % ( $P < 0.01$ ) comparing 0.1 % increase after placebo dosing.

Maximal total work after EE dosing increased significantly by

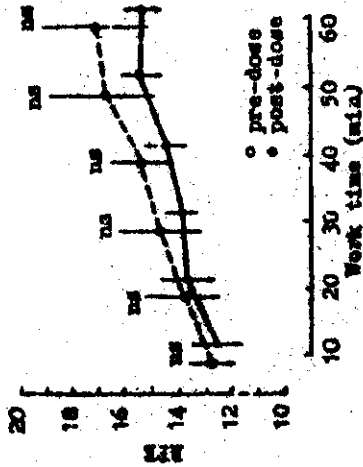


Fig. 6

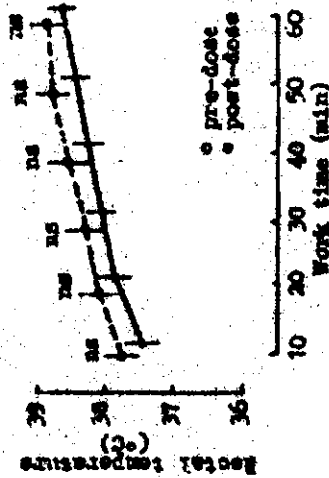


Fig. 7

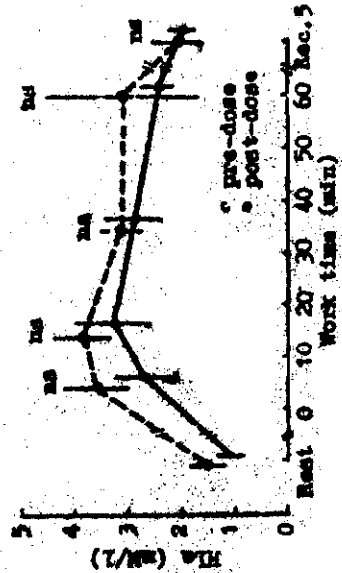


Fig. 8

Exp. -2 Max-test

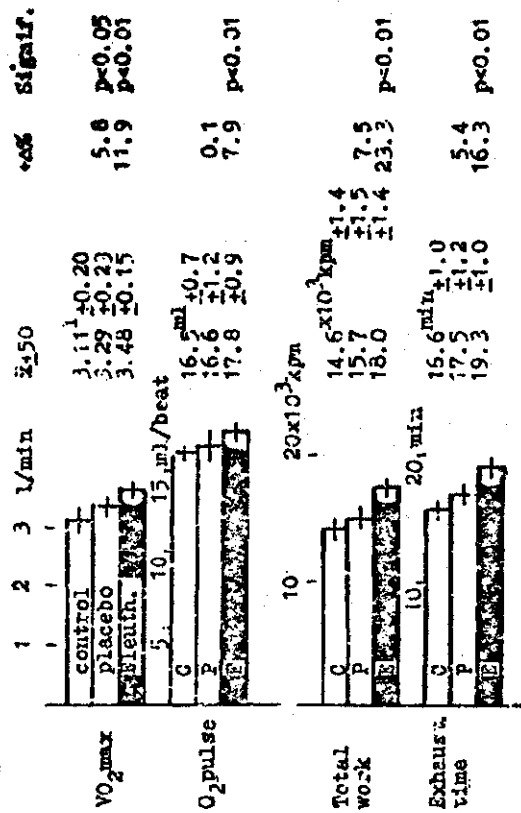


Fig. 9

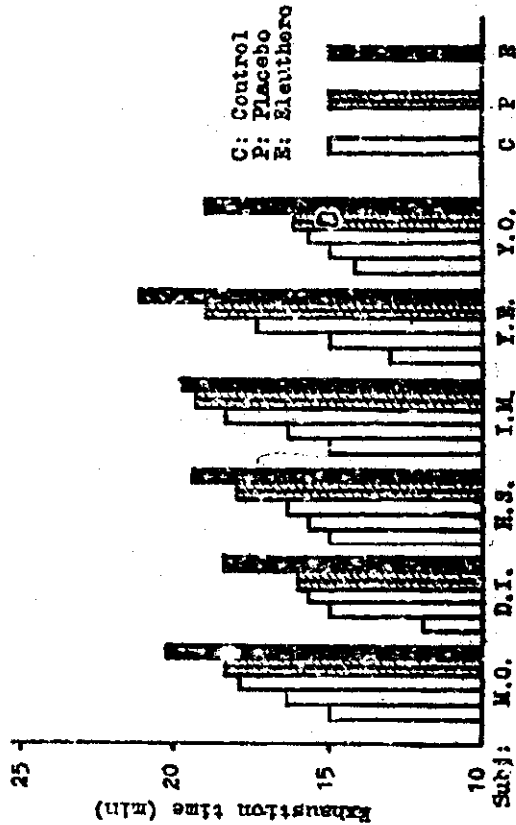


Fig. 10

23.3 % ( $P < 0.01$ ) comparing 7.5 % increase after placebo dosing. Exhaustion time after EE dosing also increased significantly by 16.3 % ( $P < 0.01$ ) comparing 5.4 % increase after placebo dosing.

Fig. 10 presented the individual exhaustion time of 6 subjects in control and after placebo and EE dosing. It could be mentioned that exhaustion time after EE dosing in all subjects was apparently longer than after placebo dosing and in the control.

From these results, it would be suggested that both maximal physical resources such as  $\dot{V}O_2$  max and  $O_2$  max pulse and maximal physical performance such as exhaustion time in situation of repeated maximal work output could be easily improved by EE dosing for 8 days.

For analysis of these phenomena, it would be considered that an improvement in capillary blood flow, tissue  $a\text{-}VO_2$  differ, and metabolism in mitochondria of muscle cell might be enhanced by stimulus from EE-agents function.

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