ACTA MEDICA LITUANICA. 2007. Vol. 14. No. 4. P. 278–284


# Effects of Cordyceps food supplement on the adaptation of physically active individuals to physical loads

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**The aim** of the study was to elucidate the effect of the natural food supplement Cordyceps on the blood haematological and biochemical indices of physically active individuals.

**Material and methods**. The study cohort comprised 28 sportsmen aged 22–25 years. After the first examination when the sportsmen's indices of blood haematological and biochemical composition had been established, the study subjects were divided into two groups (experimental and control), 14 subjects in each. Members of the experimental group were administered Codyceps in capsules, each containing 500 mg of dry fermented powder of the multicomponent fungus *Cordyceps sinensis*. Cordyceps was administered for 14 days according to the following scheme: one capsule with breakfast and one with lunch for 4 days, one capsule three times a day for 6 days, and one capsule four times a day for 4 days.

**Results**. We found that changes of the indices of red blood corpuscles, mean red corpuscle volume, red corpuscle distribution area, mean corpuscular haemoglobin and its concentration in the blood of the study participants over the experimental period were insignificant and showed no positive effect of Cordyceps on haemopoiesis. Over the experimental period, positive changes in leukocyte number and leukocyte formula were revealed. At a lower total lymphocyte count, the number of lymphocytes increased, and the percentage ratio between granulocytes and agranulocytes was levelled in the leucogram. Creatinine concentration, which statistically significantly increased over the experimental period on the background of lowered creatinekinase, ureic acid and urea levels in the blood of the study individuals, indicates the ergogenic effect of Cordyceps on the energetic system and physical and functional performance of the sportsmen's body.

**Key words:** sportsmen, blood picture, food supplements, Cordyceps, blood biochemical haematological composition

## INTRODUCTION

Training of sportsmen is a complex pedagogical process during which, in a specific way peculiar of a given sport branch, an individual is exposed to huge physical loads requiring large quantities of physical and psychic energy. In the course of such activities, numerous energetic and other substances are consumed. Recovery after a long and intensive work is also demanding as regards energetic substances (1–6). Food is not always able to cover the demand. Therefore, physicians as well as nutrition specialists are faced with the problem of providing the necessary substances in required quantities. Deprived of sufficient quantities of nutritive substances, sportsmen are forced to reduce their physical load and its intensity, otherwise the sportsman's body deteriorates instead of being strengthened; temporary and sometimes even chronic undesirable deadaptive changes become manifested. It has been scientifically proved that various food supplements are helpful in solving this problem (7–11). A great number of laboratories throughout the world are engaged in producing new food supplements, investigating their efficacy, compiling their descriptions; however, it is quite a job to get on the right way of their usage.

Food supplements abundantly offered by numerous commercial firms sometimes fail to produce the desired effect, because their constituents may evoke adverse effects, particularly if several food supplements are used at a time, which is quite often the case in sports practice (12). Over the recent years researchers in various countries get more and more interested in food supplements offered by eastern medicine (13–15). Cordyceps food supplement has been gaining popularity in sportsmen's nutrition. It is produced from the fungus *Cordyceps sinensis* growing in the Tibetan mountains 3500m above the sea level. Cordyceps has a century-long history as a means of quick recovery (16–19). Up to now, numerous clinical studies have been carried out; however, the role of Cordyceps in sportsmen's adaptation to physical loads is hardly known.

Sportsmen of the Lithuanian National Olympic team are set a task to show good starts in the 2008 Olympic Games in Peking. The basic task is to raise the adaptive reserves of the sportsmen's functional systems to ensure positive results in their training and

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in contest. Therefore, investigations of the effects of Cordyceps, a food supplement used by sportsmen, on their blood haematological and biochemical indices is important. We hypothesize that the knowledge of these effects may contribute to improving the course of adaptation of elite sportsmen to physical loads, increasing the physical and functional capacity of their body, thus improving their sport results.

The aim of the current study was to elucidate the effect of Cordyceps as a food supplement on the blood haematological and biochemical composition of sportsmen taking it.

## MATERIALS AND METHODS

The study cohort comprised 28 sportsmen aged 22–25 years, their physical activities being mainly oriented toward developing their aerobic endurance. After the first examination when the sportsmen's indices of physical development, physical working capacity, functional capacity, psychomotor functions, blood haematological and biochemical composition had been established, the study subjects were divided into two groups (experimental and control), 14 subjects in each. Members of the experimental group (Group 1) were administered Codyceps in capsules, each containing 500 mg of dry fermented powder of the multicomponent fungus *Cordyceps sinensis*. Cordyceps was administered for 14 days according to the following scheme: one capsule with breakfast and one with lunch for 4 days, one capsule three times a day for 6 days, and one capsule four times a day for 4 days. Members of both experimental (Group 1) and control (Group 2) groups did not change their daily routine: they attended lectures at the university and had their usual exercises. Individuals from both groups were examined before taking Cordyceps (study I), immediately after its withdrawal (study II) and two weeks following the administration (study III). Blood from the vein was taken for haematological and biochemical analyses. A Micros-60 haematological analyzer was employed to examine the total blood picture which included: red blood corpuscles (RBC), haemoglobin concentration (HGB), haematocrit (HCT), mean red corpuscle volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), red corpuscle distribution area (RDW), platelet (PLT), mean platelet area (PDW), platelet index (PCT) erythrocyte sedimentation rate (ESR), white blood corpuscle (WBC) count, lymphocyte (LYM), monocyte (MON), granulocyte (GRA) count and percentage.

Blood biochemical investigations were performed using a Reflatron-IV express-analyzer. The following indices were examined: creatinekinase (CK), creatinine (Crea), cholesterol (Chol), triglicerides (Tg), bilirubin (Bil), urea (Urea), ureic acid (Ua) (20).

The data obtained were treated applying the methods of mathematical statistics: calculating the arithmetical mean, its representative errors. Student's criterion for independent sets was applied for establishing difference reliability (21).

## RESULTS

At the beginning of the study, the mean blood composition indices in both groups were within normal limits (Table 1). Two weeks following Cordyceps administration, members of Group 1 showed no statistically significant changes of blood composition, except RDW. Members of Group 2 showed a statistically reliably lowered MCV, MCHC, MCH at an increasing RDW. In Group 1, the ESR over the study period showed a decreasing tendency (from 5.93 ± 1.82 to 4.58 ± 0.72 mm/h), while in Group 2 this index showed a distinct increasing tendency.

In both study groups, leukocyte count and the mean indices of their formula were within normal limits (Table 2). Over the study period leukocyte number showed a decreasing tendency in Group 1 with increasing indices of lymphocyte count and percentage immediately following Cordyceps withdrawal as well as two weeks later. Cordyceps administration caused a statistically significant increase in monocyte percentage and a decrease of granulocyte count and percentage. The leucogram showed a levelled ratio between agranulocytes and granulocytes.

Analysis of the blood biochemical indices showed that in all study individuals cholesterol level was within normal limits (Fig. 1). Over the experimental period, the mean cholesterol level in the blood of Group 1 individuals decreased from 3.94 ± 0.27 to 3.84 ± 0.28 and to 3.73 ± 0.17 mmol/l. Triglyceride levels showed an increasing tendency (Fig. 2). This tendency was even more pronounced in bilirubin levels (Fig. 3), which increased from 11.80 ± 1.89 to 17.11 ± 1.22 mmol/l. Creatinine level in Group 1 members increased statistically significantly ($p < 0.05$) (Fig. 4). Blood creatinekinase levels significantly exceeded the normal limits in Group 1 members at the beginning of study, and over the study period they statistically reliably decreased (Fig. 5). Cordyceps administration resulted in lowered ureic acid and urea levels in the blood of Group 1 members (Figs. 6, 7).

## DISCUSSION

Blood is vital for the functioning of all the organs and systems. It performs various functions by providing tissues and organs with oxygen and nutritive substances, eliminating metabolites, protecting the body against infections, regulating hormonal levels etc. Therefore, numerous authors indicate that monitoring of the sportsmen's blood haematological composition and changes caused by sport activities or food supplement intake is essential (1, 4, 22). Administration of *Cordyceps sinensis*, which is becoming more and more popular in sports training practice, involves the problem of monitoring the changes evoked by this food supplement in sportsmen's body. Our studies and the data reported by other authors (16, 17, 23) revealed no statistically significant changes in the red blood corpuscule composition. However, on the background of the data from the control group where we found negative shifts of the mean corpuscular haemoglobin level, Cordyceps administration should be evaluated positively. Positive changes in leukocyte formula under the effect of Cordyceps should be related to erythrocyte sedimentation rate normalization in the sportsmen's blood. All these data show Cordyceps to exhibit anti-inflammatory effects. This conclusion finds support in other reports (15, 24–27). Our study revealed a positive effect of Cordyceps on cholesterol metabolism; this finding is also confirmed by other authors (19, 26, 28). However, increasing levels of bilirubin, observed in our study, are a negative phenomenon. It can be related with fatigue, while increased

Table 1. **Dynamics of the sportsmen's general blood picture over the experimental period (X ± Sx)**

| Indices | | RBC 1012l | HGB g/l | HCT % | MCV fl | MCH pg | MCHC g/l | RDW % | PLT 109fl | MPV fl | PDW % | PCT 10-2fl | ESR mm/h |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Physiological marks | | 3.8–5.8 | 110–165 | 35–50 | 80–97 | 26.5–33.5 | 315–350 | 10.0–15.0 | 150–390 | 6.5–11.0 | 10–18 | 0.1–0.5 | 110 |
| Study I | E | 4.93 ± 0.08 | 148.14 ± 1.82 | 45.27 ± 0.64 | 91.93 ± 0.87 | 30.15 ± 0.33 | 327.36 ± 1.43 | 11.29 ± 0.11 | 228.14 ± 11.96 | 8.33 ± 0.14 | 12.63 ± 0.33 | 0.19 ± 0.01 | 5.93 ± 1.82 |
| | C | 5.15 ± 0.08 | 152.50 ± 2.32 | 47.01 ± 0.66 | 91.50 ± 1.08 | 29.72 ± 0.56 | 324.60 ± 2.67 | 11.21 ± 0.16 | 247.26 ± 13.23 | 8.43 ± 0.12 | 12.97 ± 0.34 | 0.21 ± 0.01 | 3.40 ± 0.22 |
| Study II | E | 4.99 ± 0.10 | 149.80 ± 2.21 | 45.92 ± 0.71 | 92.13 ± 0.76 | 30.70 ± 0.31 | 326.13 ± 1.15 | 10.79 ± 0.12 | 229.80 ± 10.58 | 8.59 ± 0.15 | 13.35 ± 0.36 | 0.20 ± 0.01 | 4.87 ± 0.79 |
| | C | 5.16 ± 0.09 | 153.90 ± 2.40 | 47.02 ± 0.61 | 91.30 ± 1.44 | 29.90 ± 0.69 | 327.4 ± 2.93 | 10.79 ± 0.11 | 242.10 ± 11.41 | 8.64 ± 0.15 | 12.94 ± 0.24 | 0.21 ± 0.01 | 4.30 ± 0.80 |
| Study III | E | 4.94 ± 0.08 | 145.75 ± 2.63 | 45.07 ± 0.78 | 91.17 ± 0.41 | 29.53 ± 0.19 | 323.75 ± 1.12 | 10.93 ± 0.16 | 242.42 ± 10.04 | 8.43 ± 0.16 | 12.3 ± 0.32 | 0.20 ± 0.01 | 4.58 ± 0.72 |
| | C | 5.17 ± 0.08 | 148.10 ± 2.69 | 46.96 ± 0.81 | 90.80 ± 1.48 | 28.68 ± 0.54 | 315.50 ± 1.49 | 11.29 ± 0.12 | 240.10 ± 14.16 | 8.37 ± 0.13 | 12.85 ± 0.34 | 0.20 ± 0.01 | 3.60 ± 0.34 |
| | | t | t | t | t | t | t | t | t | t | t | t | t |
| Et | I-II | −0.33 | −0.55 | −0.60 | −0.18 | 0.17 | 0.67 | 3.03** | −0.14 | −1.29 | −1.49 | −0.46 | 0.53 |
| | I-III | −0.07 | 0.83 | 0.30 | 0.75 | 1.53 | 1.94 | 1.86 | −0.96 | −0.50 | −0.65 | −0.94 | 0.64 |
| | II-III | 0.38 | 1.19 | 0.81 | 1.04 | 1.37 | 1.46 | −0.72 | −0.85 | 0.71 | 0.87 | −0.52 | 0.26 |
| E-Ct | I. | −1.30 | −1.10 | −1.34 | −0.19 | 0.32 | 0.97 | 0.60 | −0.36 | −1.56 | −1.02 | −0.65 | 1.11 |
| | II. | −1.40 | −1.38 | −1.48 | 0.28 | −0.01 | −0.69 | 0.24 | −0.23 | −0.79 | 0.07 | −0.41 | 0.15 |
| | III | −1.71 | −0.35 | −1.74 | 0.29 | 1.46 | 3.72** | −1.29 | 0.03 | 0.30 | 0.31 | 0.18 | 1.24 |

Abbreviations: E – Experimental group; C – Control group, * $p < 0.05$, ** $p < 0.01$, RBC – red blood corpuscles, HGB – hemoglobin concentration, HCT – hematocrit, MCV – mean red corpuscle volume, MCH – mean corpuscular hemoglobin, MCHC – mean corpuscular hemoglobin concentration, RDW – red corpuscle distribution area, PLT – platelet, mean PDW – platelet area, PCT – platelet index, ESR – erythrocyte sedimentation rate .

Table 2. **Dynamics of the sportsmen's leukocyte count and formula over the experimental period**

| Indices | | WBC 109l | GRA 109l | GRA % | MON 109l | MON % | LYM 109l | LYM % |
|---|---|---|---|---|---|---|---|---|
| Physiological marks | | 3.5–10 | 1.2–6.8 | 43–76 | 0.3–0.8 | 4–10 | 1.2–3.2 | 17–48 |
| | | 6.60 ± 0.32 | 4.29 ± 0.23 | 63.50 ± 1.49 | 0.33 ± 0.03 | 5.51 ± 0.26 | 1.99 ± 0.13 | 30.99 ± 1.41 |
| Study I | E | 6.82 ± 0.34 | 4.24 ± 0.25 | 60.76 ± 1.76 | 0.39 ± 0.04 | 6.23 ± 0.44 | 2.20 ± 0.13 | 31.68 ± 2.48 |
| | C | 6.11 ± 0.26 | 3.69 ± 0.17 | 58.52 ± 1.54 | 0.41 ± 0.03 | 7.90 ± 0.45 | 2.01 ± 0.12 | 33.57 ± 1.31 |
| Study II | E | 6.74 ± 0.28 | 4.30 ± 0.29 | 61.51 ± 2.29 | 0.45 ± 0.03 | 7.47 ± 0.54 | 1.99 ± 0.10 | 31.72 ± 1.73 |
| | C | 6.38 ± 0.33 | 3.83 ± 0.21 | 59.27 ± 1.46 | 0.40 ± 0.03 | 7.27 ± 0.42 | 2.16 ± 0.15 | 34.30 ± 1.40 |
| Study III | E | 6.68 ± 0.25 | 4.14 ± 0.22 | 60.79 ± 2.47 | 0.32 ± 0.02 | 5.36 ± 0.35 | 2.22 ± 0.16 | 33.85 ± 2.17 |
| | C | t | t | t | t | t | t | t |
| | | 1.11 | 2.12* | 2.19* | −1.82 | −3.68** | −0.16 | −1.33 |
| Et | I-II | 0.38 | 1.48 | 1.87 | −1.47 | −1.87 | −0.87 | −1.65 |
| | I-III | −0.65 | −0.52 | −0.35 | −0.28 | −0.77 | −0.77 | −0.38 |
| | II-III | 0.44 | 1.05 | 0.92 | −1.77 | −0.63 | −0.05 | −0.24 |
| E-Ct | I. | −0.79 | −1.39 | −1.32 | 0.36 | −0.30 | 1.46 | 1.04 |
| | II. | −0.31 | −1.34 | −1.55 | 3.85** | 2.28* | 1.12 | 0.47 |
| | III | | | | | | | |

Abbreviations: E – Experimental group; C – Control group, * $p < 0.05$, ** $p < 0.01$, WBC – white blood corpuscle count, GRA – granulocyte, LYM – lymphocyte, MON – monocyte count and percentage.

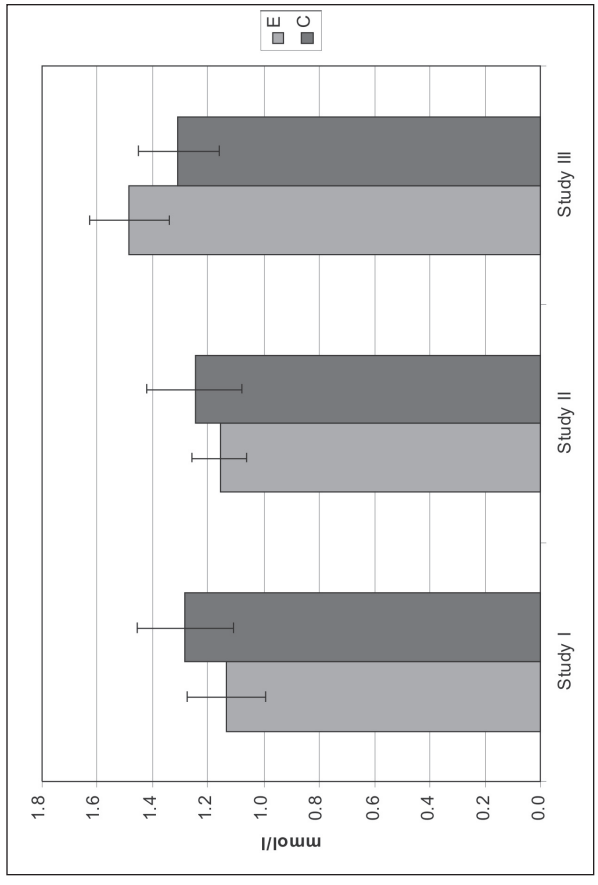


**Fig. 1.** Cholesterol concentration in the sportsmen's blood




**Fig. 2.** Triglycerides concentration in the sportsmen's blood

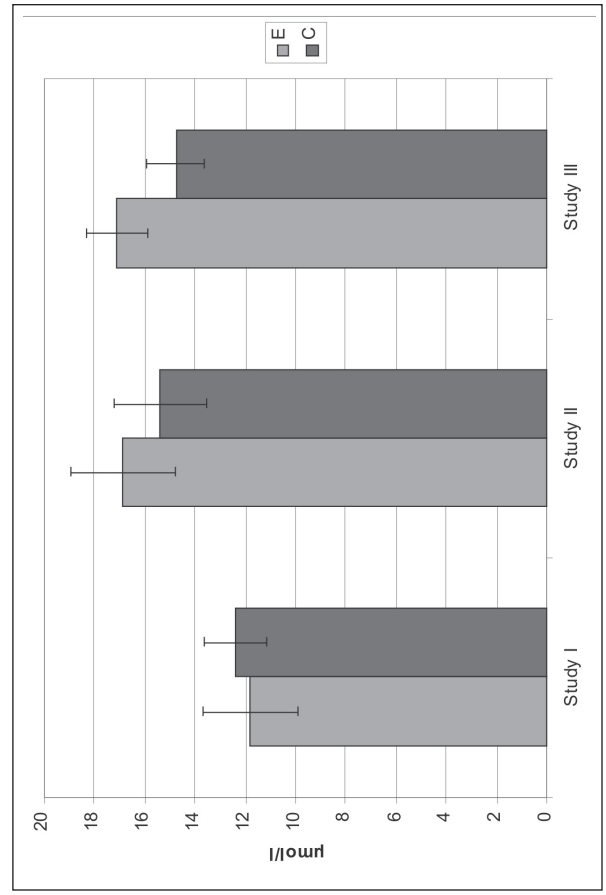


**Fig. 3.** Bilirubin concentration in the sportsmen's blood

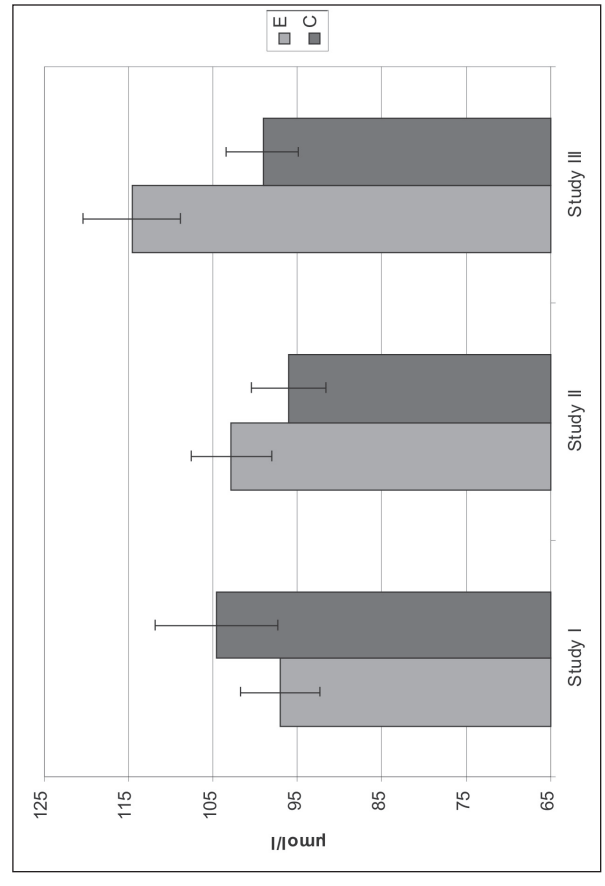


**Fig. 4.** Creatinine concentration in the sportsmen's blood

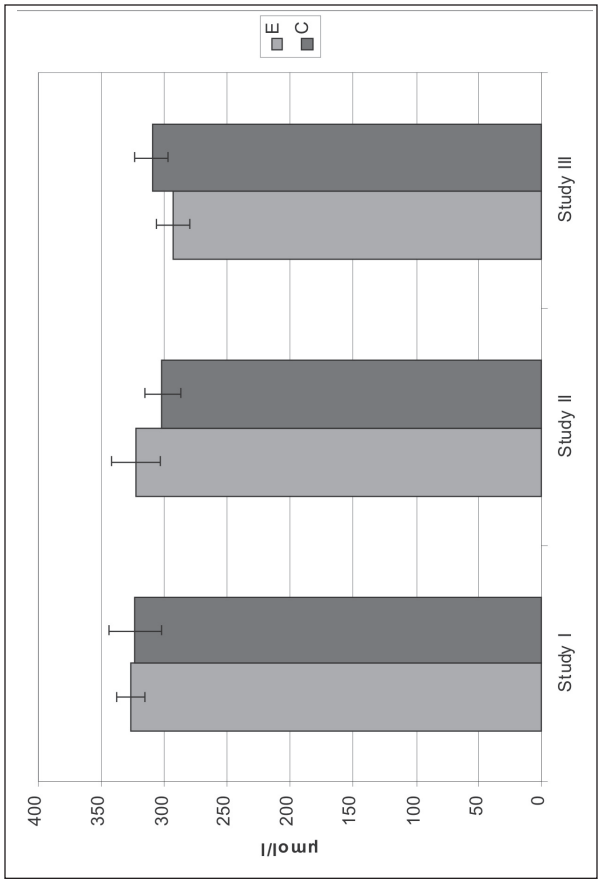


**Fig. 6.** Ureic acid concentration in the sportsmen's blood

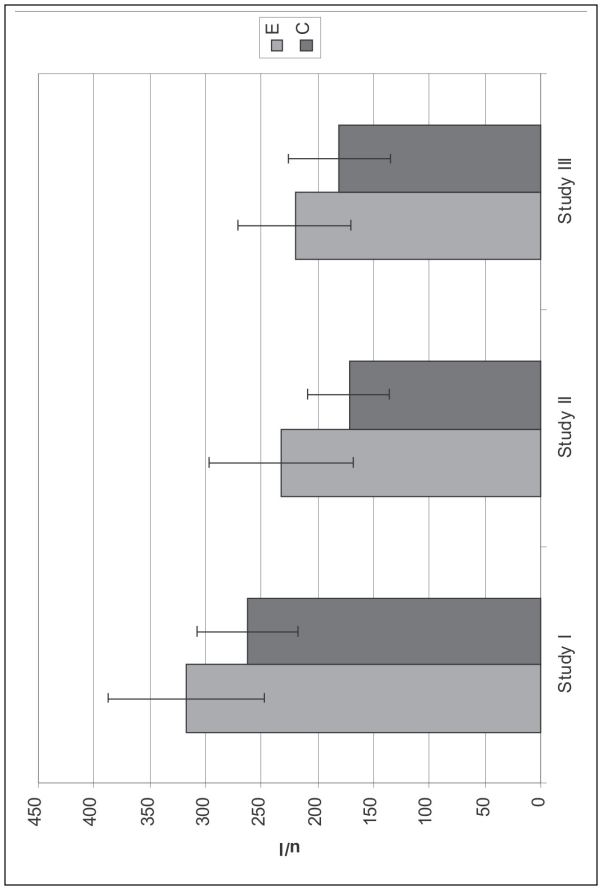


**Fig. 5.** Creatinekinase concentration in the sportsmen's blood

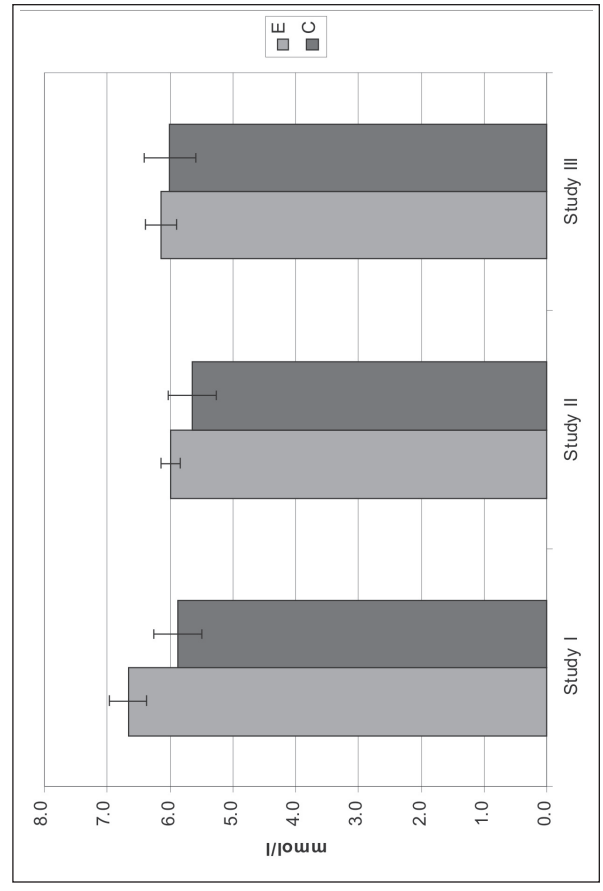


**Fig. 7.** Urea concentration in the sportsmen's blood

creatinine levels at normalizing blood creatinekinase levels can be regarded as an ergogenic effect of Cordyceps on the biochemical processes that take place in the sportsmen's body, which provides for increasing muscular power, bodily endurance. The data of sportsmen's questioning showed that Cordyceps had no negative effects on their organism. As soon as during the first three days of Cordyceps intake the members of the experimental Group 1 felt increased appetite, which also survived after seven days. The quality of their sleep improved, they sooner got asleep, the sleep was deeper, and they felt better in the morning. The self estimation of physical condition of the members of Group 1 improved, they felt more energetic and hardy.

While summarizing the research data it is possible to state that changes of the indices of red blood corpuscles, mean red corpuscle volume, red corpuscle distribution area, mean corpuscular haemoglobin and its concentration in the blood of the study participants over the experimental period were insignificant and showed no positive effect of Cordyceps on haemopoiesis.

Over the experimental period, positive changes in leukocyte number and leukocyte formula were revealed. At a lower total lymphocyte count, the number of lymphocytes increased, and in the leucogram the percentage ratio between granulocytes and agranulocytes was levelled.

Creatinine concentration, which statistically significantly increased over the experimental period on the background of lowered creatinekinase, ureic acid and urea levels in the blood of the study individuals indicate the ergogenic effect of Cordyceps on the energetic system, physical and functional performance of the sportsmen's body.

Received 23 May 2007
Accepted 19 October 2007

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**Kazys Milašius, Rūta Dadelienė, Marija Pečiukonienė, Radvilė Malickaitė**

## MAISTO PAPILDO KORDICEPSO POVEIKIS FIZIŠKAI AKTYVIŲ ASMENŲ ADAPTACIJAI ESANT FIZINIAM KRŪVIUI

*S a n t r a u k a*

Sportininkų mityboje vis labiau populiarėja Kinijoje gaminamas maisto papildas kordicepsas (*Cordyceps sinensis*), kuris gaminamas iš grybo *Cordyceps sinensis*, augančio 3500 m aukštyje virš jūros lygio Tibeto kalnuose. Kordicepsas jau daugelį šimtmečių vartojamas jėgoms atgauti. Šiuo metu jau atlikta daug klinikinių mokslinių tyrimų, tačiau dar nėra pakankamai duomenų, kurie patvirtintų kordicepso poveikį sportininkų organizmo adaptacijai esant fiziniam krūviui. Lietuvos olimpinės rinktinės sportininkams keliamas uždavinys gerai startuoti olimpinėse žaidynėse, kurios vyks Kinijoje, Pekine, 2008 m., todėl svarbiausia yra padidinti jų organizmo funkcinių sistemų adaptacinį rezervą, kad įtemptas darbas treniruotėse ir varžybose duotų teigiamus rezultatus.

**Darbo tikslas** buvo nustatyti natūralaus maisto papildo kordicepso poveikį fiziškai aktyvių asmenų kraujo morfologinei ir biocheminei sudėčiai.

Ištirti 22–25 metų 28 sportininkai, kurių fizinė veikla buvo daugiau orientuota į aerobinės ištvermės lavinimą. Po pirmojo tyrimo, kurio metu visiems buvo nustatyti kraujo morfologinės ir biocheminės sudėties rodikliai, tiriamieji buvo suskirstyti į dvi grupes (eksperimentinę ir kontrolinę) po 14 asmenų. Eksperimentinės grupės tiriamieji 14 dienų vartojo kordicepso kapsules didindami jų dozę: 4 dienas po 1 kapsulę ryte ir per pietus, 6 dienas po 1 kapsulę 3 kartus per dieną ir 4 dienas po 1 kapsulę 4 kartus per dieną. Abi grupės buvo ištirtos prieš papildų vartojimą (I tyrimas), tuoj po jų vartojimo (II tyrimas) ir praėjus 2 savaitėms po jų vartojimo (III tyrimas). Morfologiniams ir biocheminiams tyrimams kraujas buvo imamas iš venos. Bendras kraujo tyrimas buvo atliekamas hematologiniu analizatoriumi „Micros-60“ (Prancūzija), biocheminius tyrimus atlikome ekspresanalizatoriumi „Reflatron-IV“.

Eksperimentinės grupės nariams dvi savaites pavartojus kordicepsą statistiškai reikšmingų kraujo sudėties pokyčių nenustatyta, išskyrus raudonųjų kraujo kūnelių pasiskirstymą plote (RDW). Šios grupės narių eritrocitų nusėdimo greitis per tyrimų laikotarpį mažėjo vidutiniškai nuo 5,93 ± 1,82 iki 4,58 ± 0,72 mm/val., o kontrolinės grupės narių, priešingai, šis rodiklis didėjo. Per eksperimentinį kordicepso vartojimo laikotarpį pirmosios grupės narių kraujyje leukocitų mažėjo didėjant limfocitų kiekiui ir procentiniams rodikliams. Pavartojus šį papildą statistiškai reikšmingai padidėjo monocitų procentas, sumažėjo granuliocitų skaičius ir jų procentinis rodiklis. Santykis tarp agranuliocitų ir granuliocitų leukogramoje išsilygino. Mažėjant bendrajam leukocitų kiekiui padidėjo limfocitų. Per eksperimentinį laikotarpį statistiškai reikšmingai padidėjo kreatinino koncentracija, mažėjo kreatinkinazės, šlapimo rūgšties ir šlapalo koncentracijos tiriamųjų kraujyje. Tai rodo ergogeninį kordicepso poveikį sportininkų organizmo energetinei sistemai ir fizinėms bei funkcinėms galioms.

**Raktažodžiai:** sportininkai, hematologinė ir biocheminė kraujo sudėtis, maisto papildas kordicepsas