

The impact of *Lepidium meyenii* (MACA) supplementation on basketball-related performance and anti-fatigue ability: a double blind crossover study

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Project summary

Supplementation with *Lepidium meyenii* (MACA) has been shown in animal studies to increase blood lactate clearance and rapid lactate removal, which may be effective in reducing fatigue during intermittent exercise. However, no studies have investigated the effects of MACA supplementation on interval exercise and basketball performance. We hypothesized that MACA supplementation could reduce fatigue and improve performance in elite healthy male basketball players. This study aimed to determine the effectiveness of MACA compared to placebo on overall basketball performance. In this randomized crossover study, ten elite healthy male basketball players were included. Following a 17:00 PM training routine, participants completed a two-week supplementation with 2000 mg of MACA or placebo. After supplementation, participants underwent a Basketball Jump Shooting Accuracy Test and Repeated Sprint Ability Test.

General information

Protocol title: The impact of *Lepidium meyenii* (MACA) supplementation on basketball-related performance and anti-fatigue ability: a double blind crossover study (Date: 30/01/2024; ID: NA)

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1 INTRODUCTION.

2 *Lepidium meyenii* (MACA) is a Peruvian cruciferous vegetable growing more than 4000 m and
3 cultivated for over 2000 years (1). Traditionally, the Andean people used MACA as food or medicine
4 (2). They believed consumption of MACA improves stamina and strength (1). In the 13th century, Inca
5 consumed MACA prior to entering battle to increase their energy (3). Now the MACA has attracted
6 interest as a dietary supplement because of its potential positive effects on physical and sexual activity
7 (4).

8 Several studies have been conducted to examine its biological activity, and have shown increased
9 endurance capacity and protection against exercise-induced oxidative stress (5-7). In animal
10 experiments, supplementation with MACA was found to improve endurance exercise capacity and
11 enhance clearance of metabolites such as blood lactate in mice (8-11). However, we found that most
12 scientific research on the biological activity of MACA in humans has focused on improving sexual
13 performance or fertility (12). To date, one study has demonstrated that 14 days of MACA
14 supplementation improved 40km time trial performance and libido in trained male cyclists (7).
15 Therefore, more well-designed, randomized, placebo-controlled studies are needed to assess the effect
16 of MACA supplementation on the clearance of blood lactate and specific exercise performance.

17 Basketball players perform a range of technical skills during the game, including speed, agility,
18 anaerobic capacity, vertical jumping ability, and game-specific skills. This high-intensity interval
19 exercise has been found to increase the accumulation of lactic acid in the blood and lead to induced

20 fatigue (13-15). In animal studies, MACA supplementation has been demonstrated to increase the
21 clearance of blood lactate (10, 16). However, no studies have examined the effects of MACA on
22 basketball-related performance and lactate clearance in basketball players. We hypothesized that
23 MACA supplementation could reduce fatigue and improve performance in trained healthy male
24 basketball players, and aimed to determine the effectiveness of MACA compared to placebo in overall
25 basketball performance.

26

27 **METHODS**

28 **Study Design**

29 The study used a double blind, randomized controlled, crossover, repeated measures, placebo
30 (control) trial design. Participants were randomized on a 1:1 basis to supplement daily with MACA
31 (MC) or placebo (PL) for two weeks before sport performance tests, and separated by 14 days.
32 Randomization was performed using a permuted block design with a computer random number
33 generator by a research assistant not involved in any other aspect of the study. All researchers and those
34 involved in outcome assessments (i.e. basic data collection, individuals performing sport performance
35 tests, data entry, and analyses) were blinded to group assignments. The study was approved by the
36 Institutional Review Board of Jen-Ai Hospital - Dali Branch (JCH-IRB 111-24). Participants were
37 informed of the risks and purposes of the study before written consent was obtained. The study

38 complied with the World Medical Association Declaration of Helsinki–Ethical Principles for Medical
39 Research Involving Human Participants. We adhered to the Consolidated Standards of Reporting Trials
40 (CONSORT) guidelines for reporting on randomized clinical trials (17).

41 **Participants**

42 We recruited ten healthy male trained basketball players (age: 20.1 ± 0.3 year; body mass: 79.2 ± 11.1
43 kg; height: 181.9 ± 6.0 cm; body fat: $12.6 \pm 6.0\%$). The sample size computation was based on the
44 study by Mark Stone (7). It revealed a significant improvement ($p=0.01$) in time to complete 40km
45 from baseline to post supplementation in the MACA trial with only 8 subjects (7). All participants were
46 college elite basketball players competing in a Taiwan university basketball association who
47 voluntarily participated in this study. The inclusion criteria were: (i) healthy male adults, those
48 individuals who are free of pain, insomnia, or other injuries recently, without any medication used in
49 recent 2 months, (ii) basketball players competing in a Taiwan university basketball association for
50 more than two years. Interested participants were excluded if they: (i) were below 20 years old, (ii) did
51 not have won at least eighth place in national-level basketball competitions, (iii) were with
52 cardiovascular diseases or any disease that made subjects feel ill. All exclusion criteria were
53 determined by interview.

54

55 **Study Setting**

56 All the study was conducted in the indoor basketball stadium at the National Taiwan University of
57 Sport. We control the temperature and humidity of the basketball stadium via the air conditioner. The
58 study commenced in June 2022 and supplementation and sport performance tests were completed in
59 September 2022.

60 Protocol

61 Experimental procedure

62 Participants completed a supplementation period of two weeks during which they were provided
63 with 2000mg of either MACA (MacaPro[®] Gelatinized Maca Powder, Lytone, Taipei, Taiwan) or a
64 Placebo (100% corn-starch maltodextrin powder) after the daily training at 17:00 pm (7). The MACA
65 supplement is derived from a concentrated 6:1 blend of black, red, and yellow MACA root compounds,
66 with an 80:15:5 ratio respectively. The chemical composition of the MACA supplement, an extract
67 consists of macamides as discussed in Zheng et al. (18). The plant name has been checked with “World
68 Flora Online” (www.worldfloraonline.org). According to the ingredient information of this product,
69 no other ingredients are mentioned, it is a purified extract powder. This company is a major
70 manufacturer of MACA. The main components of MACA have been analyzed by ultrahigh-
71 performance liquid chromatography (HPLC) (19). The MACA supplement or Placebo were supplied
72 as orange-white capsules with the same appearance. After the supplement was given, the subject would
73 be confirmed to have finished taking it. The subjects were asked to record the dietary status for three
74 days since three days before each testing session to make sure the same diet was consumed, and
75 educated the subjects to avoid eating or drinking irritating food and taking any form of health
76 supplements or ergogenic agents until the end of the experiment, and ensured that ingesting the same
77 diet and avoiding strenuous exercise on the day before the next experiment.

78 During the two weeks of the supplementation process, the subjects were asked about their usage
79 status and physical condition every day. If they felt any discomfort or took other medications, they
80 immediately stopped administering the supplements and then continued to observe and record the
81 participants' physical condition and were excluded from the trial. They were replaced with different
82 participants. All ten athletes completed the entire protocol without adverse events after MACA
83 supplementation.

84 Three days before the test, we asked the participants to record their diet and to consume the same
85 diet at the same time in the next experiment. On the day of the experiment, we used photographs to
86 record the breakfast and lunch consumed by the participants and asked the participants to repeat the
87 same meals in the second experiment. The nutritional composition of breakfast and lunch was
88 $11.9\pm 2.4\%$ protein, $41.6\pm 16.7\%$ carbohydrate, $26.8\pm 6.1\%$ lipid, and 1353.6 ± 135.4 kcal.

89 After two weeks of the supplement, participants begin formal experimentation after arriving at
90 the basketball stadium at 15:00 p.m. First, the participants were asked to lie on a bench for 10 minutes
91 with a heart rate monitor (Polar, Finland). After 10 minutes resting, the pre-exercise blood lactate level
92 was collected by the nurses. The disposable pen needle was used for blood collection, and 75% alcohol
93 was used to sterilize the puncture site and the fingertips.

94 They performed two identical warm-up exercises and three court-based fitness tests: (1)
95 countermovement jump test, (2) Basketball Jump Shooting Accuracy Test and, (3) Interval sprint
96 training. All outcome measures presented acceptable test-retest reliability (20-23). During the test,
97 participants then provided ratings of perceived performance and perceived exertion (RPE) using 10-

98 point Likert scales (with 1 indicating a minimum response and 10 indicating a maximum response).

99 Capillary blood samples were collected to assess the blood lactate concentration before and after the

100 interval sprints test. All testing sessions were completed with a period of rest of at least 14 days for

101 complete recovery and MACA wash-out.

102

103 **Countermovement jump test**

104 The countermovement jump test is performed using GymAware (GymAware, Kinetic

105 Performance Technology, Canberra, Australia) equipment (24). The participants first stands in front of

106 the instrument with his feet shoulder-width apart, crosses his arms and squats down quickly until his

107 thighs are parallel to the ground then immediately jumped upward as high as they could. Three jumps

108 were measured with 1 minute rest for each participant. The mean height of the three jumps was

109 obtained.

110

111 **Basketball Jump Shooting Accuracy Test**

112 The first test was the basketball jump shooting Accuracy Test (BJSAT), which has been used in

113 the past with sufficient reliability to two and three-point shooting accuracy (22). All athletes were given

114 a demonstration and performed a 2-min shooting warm-up from the shot locations. They were

115 instructed to attempt four shots with an even spread from the left and right sides of the court and from

116 two- and three-point distance. In total, the test consisted of 8 x jump shot attempts at predetermined

117 locations on the court. The shot order for the BJSAT ensured that athletes alternate between two-point

118 and three-point distances and do not take consecutive jump shots from either distance throughout the
119 test. All shots were attempted with athletes placing both feet within a marked area at each shot location
120 (60 cm x 60 cm). If an athlete attempted a jump shot with one or both feet outside of the marked area,
121 the athlete continued the trial; however verbal instruction was given immediately to ensure both feet
122 were placed within the marked area for the remaining shot attempts. The scoring methods is shown in
123 Table 1. The male athletes used standard size 7 basketballs.

124

125 Table 1. Scoring criteria for the Basketball Jump Shooting Accuracy Test.

Score	Description
3	The basketball passes through the basket without touching the rim or backboard.
2	The basketball make contact with the rim or backboard before passing through the basket.
1	The basketball makes contact with the rim or backboard, but does not pass through the basket.
0	The basketball does not come in contact with the rim or backboard and does not pass through the basket.

126

127 **Repeated Sprint Ability Test**

128 After the 10 minutes rest and recovery, the participants perform the next test of Repeated Sprint
129 Ability test (40× 15m with a 1:4, exercise : rest time ratio, such as 2 seconds :8 seconds) (24). This
130 test has been proven to reflect the sprinting ability of basketball players (25). Sprint direction was
131 alternated for each sprint so the finish became the start for each consecutive sprint. There were several

132 types of repeat sprints test protocols. Half court, multiple change of direction protocol may not a typical
133 repeat sprint test method, but it's a routine of their daily basketball training in Taiwan. Previous studies
134 within the field have reported that familiarization is a crucial component as athletes typically find a
135 preferable movement repertoire that enables them to achieve their best result (26).

136

137 **The lactate clearance rate**

138 Between every 10 sprints, the participants walked back to the start point and rested. The capillary
139 blood lactate, mean heart rate and RPE were measured after completion of each 10 times repeated
140 sprint ability protocol. After full completion and resting in standing position for 5 minutes, the capillary
141 blood lactate was taken and analyzed to measure the lactate clearance rate. The lactate clearance rate
142 was calculated using the equation: Decreased percentage (%) = [(data during recovery period - data at
143 exhaustion) / data at exhaustion] × 100%. Finally, three vertical jump tests were measured after the
144 whole test to be used as indicators of neuromuscular fatigue in the legs.

145

146 **Statistical Analysis**

147 Data analysis was performed using SPSS software (version 20, Chicago, IL, USA). A
148 descriptive analysis was performed using means and standard deviations. Normality of distribution
149 was tested using the Shapiro-Wilk test. A two-way ANOVA Paired t-test was used to assess the
150 differences in every 10 times repeated sprints, mean heart rate and RPE between MACA group and

151 placebo trials. Paired t-test was used to assess the differences in the Fatigue index, BJSAT score and
152 lactate clearance rate. The statistical power was s performed using G*Power software package (Version
153 3.1.9.4, Kiel University). Statistical significance was set at $p < 0.05$.

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